The Minas Basin: Scots Bay faunal survey, project 03D-002 and 03D-003

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Investigations on the Ecology of the Bay of Fundy

THE MINAS BASIN - SCOTS BAY FAUNAL SURVEY

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Project 03D-002 and 03D-003

August 21, 1977

A series of projects on the enumeration and interactions of the flora, fauna, chemistry, hydrology and geology of the Bay of Fundy with an emphasis on the Minas Basin and Scots Bay. The projects were conducted under the Summer Job Corps Program supported by the Department of Manpower and Immigration, the Atlantic Regional Laboratory of the National Research Council, and the Biology and Chemistry Departments of Acadia University.

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F. J. Simpson
Director, ARL/NRC

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INTRODUCTION

The Minas Basin - Scots Bay project was undertaken to obtain baseline biological data, primarily on the intertidal invertebrate fauna. This study was originally designed as two projects, but was easier to co-ordinate as one comparative study. Therefore all results are presented in this one report. The information presented concerning species relationships and densities will serve as a useful comparison to future studies in estimating changes in the Minas Basin and Scots Bay areas following any tidal power implementation.

Historically, little research has been undertaken in the Minas Basin - Scots Bay areas. The most comprehensive study is that of Bousfield and Leim, 1958. This study encompasses work done in 1920 and 1958, and presents a list of over one hundred and fifty invertebrate species, as well as physical and hydrographical information.

The Fundy Tidal Power Symposium 1977 (Daborn ed.) brings together much recent information on biological, chemical, and physical characteristics of the Bay of Fundy - Minas Basin area.

The paucity of information in this unique region is cause to undertake future studies of a similar nature, prior to construction of any tidal power stations.

THE STUDY AREAS

The areas of main concern in this study are shown in Figure 1.

The Minas Basin and Scots Bay areas represent two contrasting environments. The Minas Basin at high tide encompasses 696 Km^2. At extreme low tides 245 Km^2 of the intertidal zone is exposed in the form of extensive mud flats. Much of the Basin is less than 25 meters in depth, with a mean depth of 14.6 meters at low tide (0 datum). The mean rise in tide above datum is approximately 13.8 meters. Within the Basin, the extensive tides constantly resuspend sediments resulting in a high turbidity. The Minas Basin is bordered by extensive salt marshes and has significant amounts of freshwater drainage. Combined with the extensive mud flats, these features compose a unique ecosystem. Potentially, pronounced changes could occur in this system following tiday power development.

Scots Bay on the other hand represents an exposed shoreline with little in the way of intertidal mud flats, or salt marshes. Mean high water level is 10.7 meters. Water temperatures in Scots Bay are typical of the Bay of Fundy, and in summer are generally 3 to 8^{o} C less than the Minas Basin. Scots Bay would probably exhibit only small changes following tidal power development.

The turbidity of this water is much lower than the Minas Basin. Suspended sediments are on average 6.6 mg/1 in Scots Bay, as compared to 20 to 200 mg/1 in the Minas Basin.

This report is presented as a series of independent sub-projects, these include: General transect mud-flat sampling; *Corophium* and Polychaeta transect mud-flat sampling; Insect survey; Isopoda; Tunicata; and a salinity and temperature study.

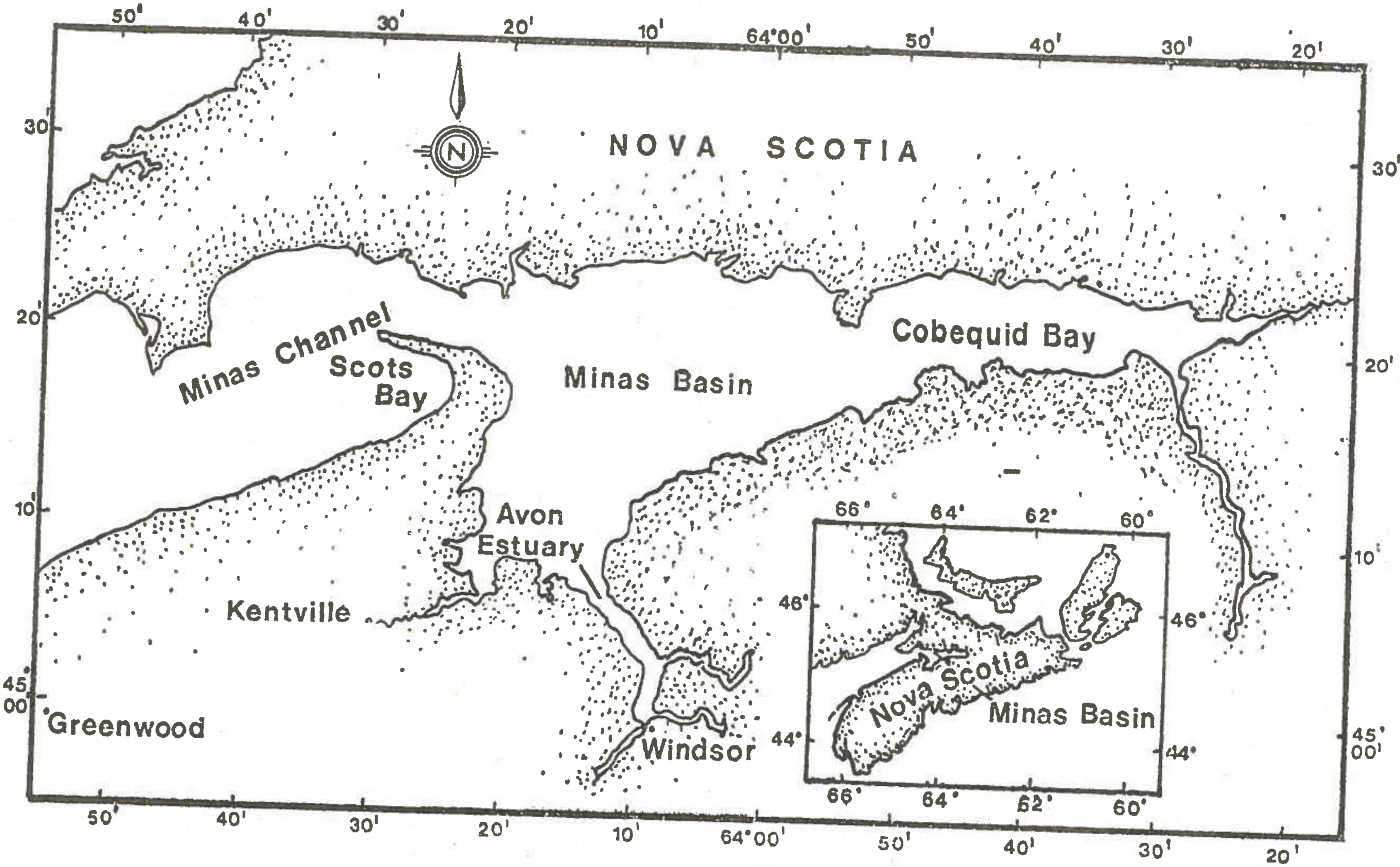


Figure 1. Location of study area

II. MATERIALS AND METHODS

1. GENERAL TRANSECT SAMPLING PROCEDURE

Sixteen linear transects were established along the major sediment types in the western portion of the Minas Basin to sample invertebrates (table 1). Transects 3, 5, 6, 8, 9, 10, 11, 13, 14 and 15 were established for the general sampling, with the remainder used for the *Corophium* - Polychaeta subproject (see fig 2). Each transect established extended from the high water line to the low water line (see figure 3).

Samples were taken in duplicate with a 15 cm x 15 cm x 10 cm deep substrate sampler. Sample stations were 100 M apart.

The invertebrates were extracted with a sieve (Tyler #20) in the field and placed in 4 oz. jars containing 10 percent formalin. The invertebrates were sorted, and later counted in the laboratory and stored in 70 percent ethanol.

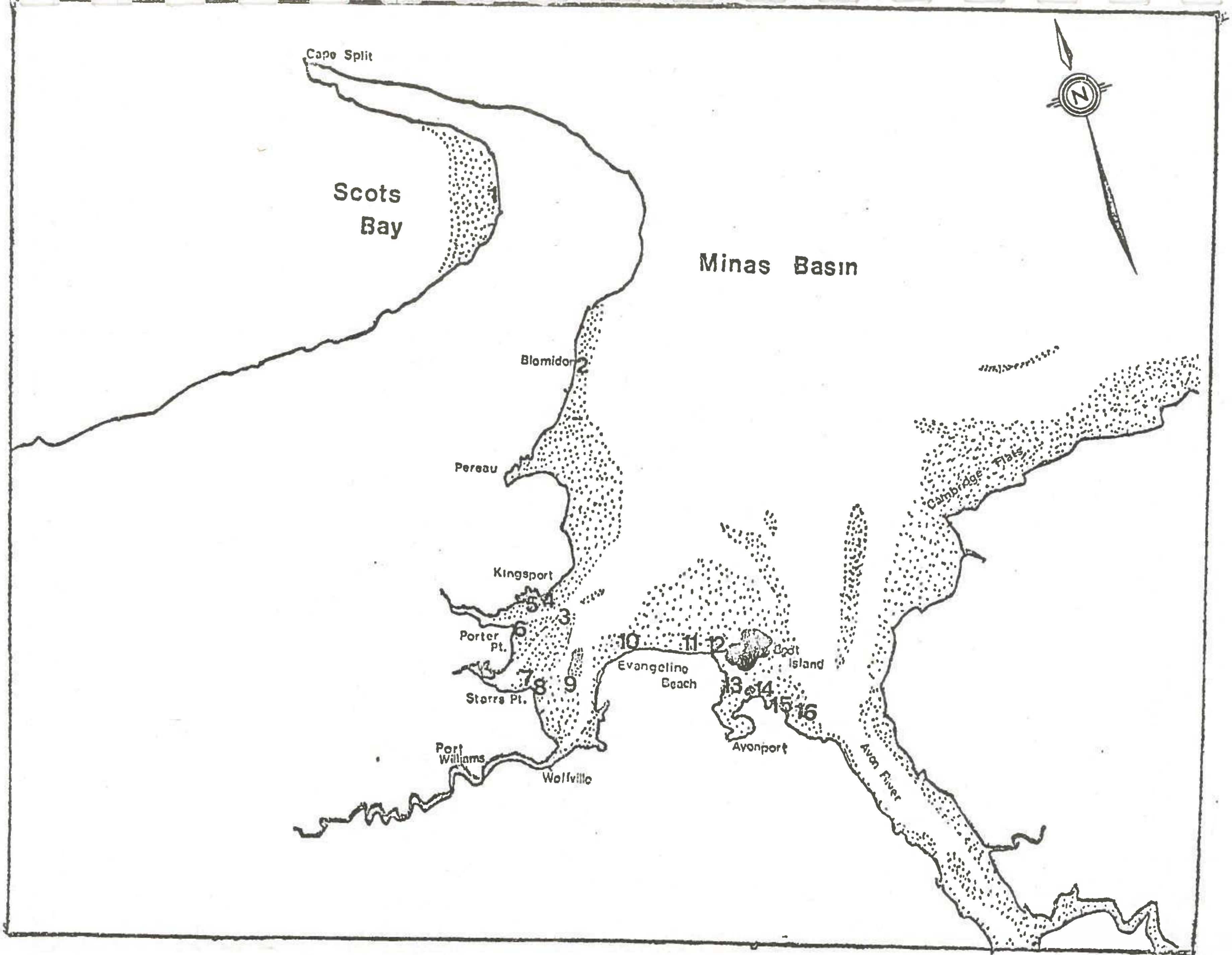

Cape Split
Scots Bay
Minas Basin
N
1
Blomidon
2
Pereau
Cambridge Flats
Kingsport
5
4
3
6
Porter Pt.
7
8
9
Starrs Pt.
10
Evangeline Beach
11
12
Boot Island
13
14
15
16
Avonport
Avon River
Port Williams
Wolfville

FIGURE 2.

Figure 3. Linear Transect.

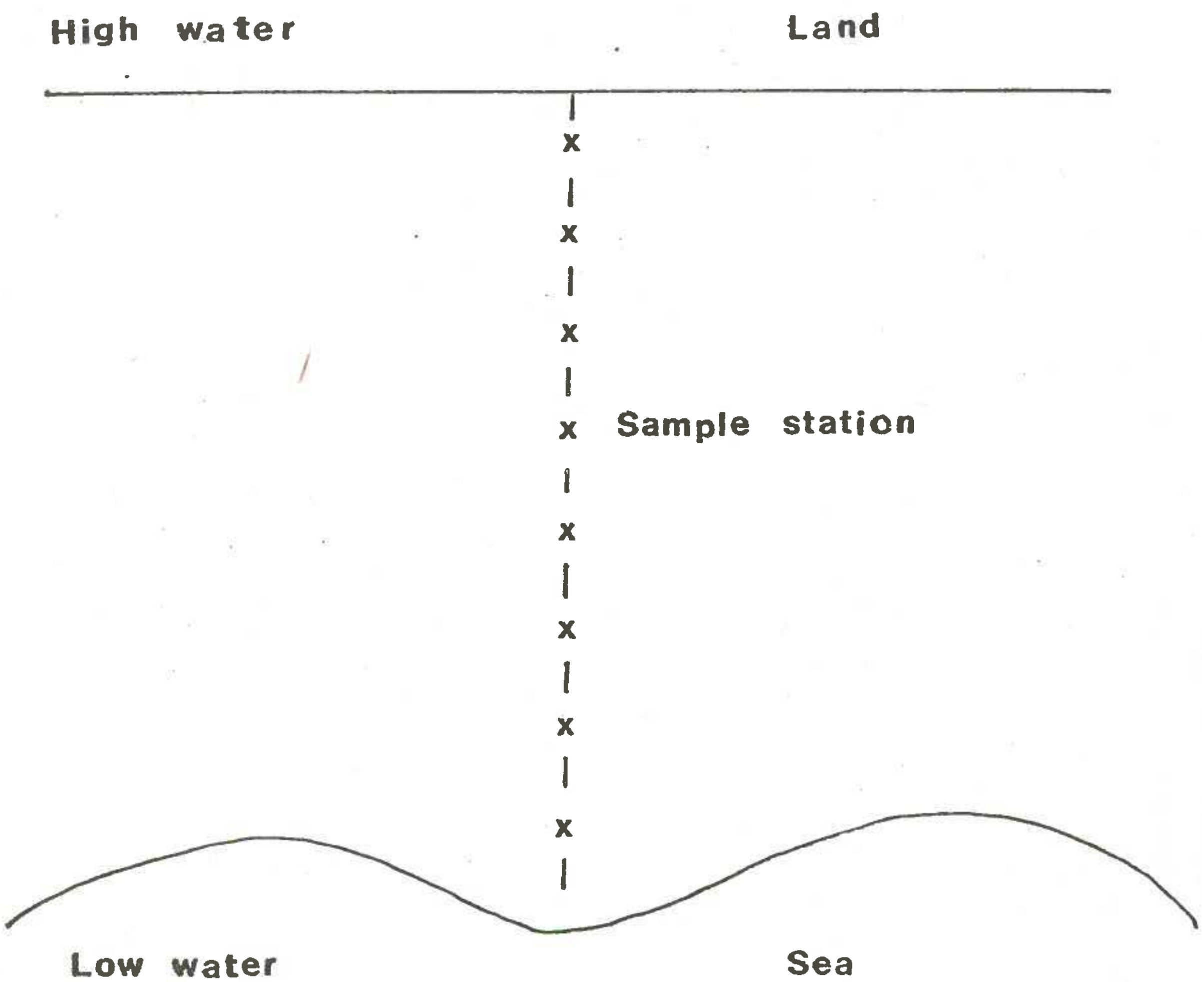


TABLE 1. TRANSECT LOCATION AND LENGTH

'ransect Number	Location	Total length of Transect (metres)	Distance Between Sample Stations	Samples Taken
1	Scots Bay	900 m	150 m	triplicate
2	Blomidon	600 m	100 m	triplicate
3	Kingsport Mud Bar	500 m	100 m	duplicate
4	Kingsport Beach	500 m	100 m	triplicate
5	Kingsport Beach	400 m	100 m	duplicate
6	Porters Point	500 m	100 m	duplicate
7	Starrs Point	1200 m	150 m	triplicate
8	Starrs Point	900 m	100 m	duplicate
9	Starrs Point Mud Bar	300 m	100 m	duplicate
10	Evangeline Beach West	600 m	100 m	duplicate
11	Evangeline Beach	1900 m	100 m	duplicate
12	Evangeline Beach	1650 m	150 m	triplicate
13	East Point	300 m	100 m	duplicate
14	Oak Beach	500 m	100 m	duplicate
15	Avonport	800 m	100 m	duplicate
16	Avonport	900 m	150 m	triplicate

2. MINAS BASIN - SCOTS BAY INSECT SURVEY

The objective of this project was to implement a general survey of insects in selected study areas of the Minas Basin and Scots Bay area.

Materials and Methods

The field procedure involved collecting from four study sites: (1) Scots Bay (2) Kingsport (3) Canard and (4) Wolfville (see Figure 4). Samples were taken from runoff streams, selected vegetation types, salt marsh pools and random collections.

Collecting from runoff waters involved using dip nets at one hundred dips per stream. At each of the Kingsport, Canard, and Wolfville sites, a number of salt marsh ponds were sampled with a dip method. Since the majority of ponds were quite small, they were well covered by 10 dips per pond. Each dip could be described as an "S" sweep (shore-openwater-shore). The insects were sorted out with either forceps or a bulb operated pipette. Detailed sorting, was later carried out in the laboratory.

Sweeping was carried out in all acceptable areas at each study site. The major limitations to sweeping were: lack of vegetation cover, wet vegetation, very dense and/or beaten down vegetation, sparse vegetation with a muddy/wet substrate, and to some extent strong winds.

Since the project was concentrated on variety of species, random samples were taken in the vicinity of the sample sites. To this set of data belongs all insects collected at sites where organized collection was difficult or impossible to achieve, as was the case on mud flats at low tides, under stones, or in driftwood.

THE STUDY AREAS

Wolfville

W1 - area of low density *Spartina alterniflora.*

W2 - area of low density *Spartina alterniflora.*

W3 - area of very dense *Spartina alterniflora.*

W4 - area of very dense *Spartina patens* with occasional *Spartina alterniflora.*

W5 - area of assorted salt marsh grasses with patches of dry crushed substrates.

Canard

C1 - area of low density *Spartina alterniflora.*

C2 - area of low density *Spartina alterniflora.*

C3 - area of low density *Spartina alterniflora.*

C4 - area of dense *Spartina alterniflora.*

C5 - area of high density *Spartina patens.*

C6 - area of dense *Spartina alterniflora* and assorted salt marsh grasses.

C7 - dense *Spartina alterniflora* and assorted salt marsh grasses.

Kingsport

K1 - an area of exposed substrate, no vegetation.

K2 - an area of low density *Spartina alterniflora*.

K3 - an area of dense *Spartina alterniflora*.

K4 - an area of low density *Spartina alterniflora*.

K5 - an area of dense *Spartina alterniflora*.

K6 - an area of dense *Spartina alterniflora* and assorted salt marsh grasses, just below the highest tide mark.

Scots Bay

Random sampled, high beach is gravelly, no salt marsh is present.

The main sample collection took place in July at this study site. Large insect species were classified, spread and pinned in the laboratory. Small insect species were preserved in AGA solution, Araneae in Kahle's Fluid. Acari in Oudeman's Fluid, larvae and caterpillars in Pampel's Fluid. Other specimens were preserved in 75% ethanol with a small amount of glycerine added.

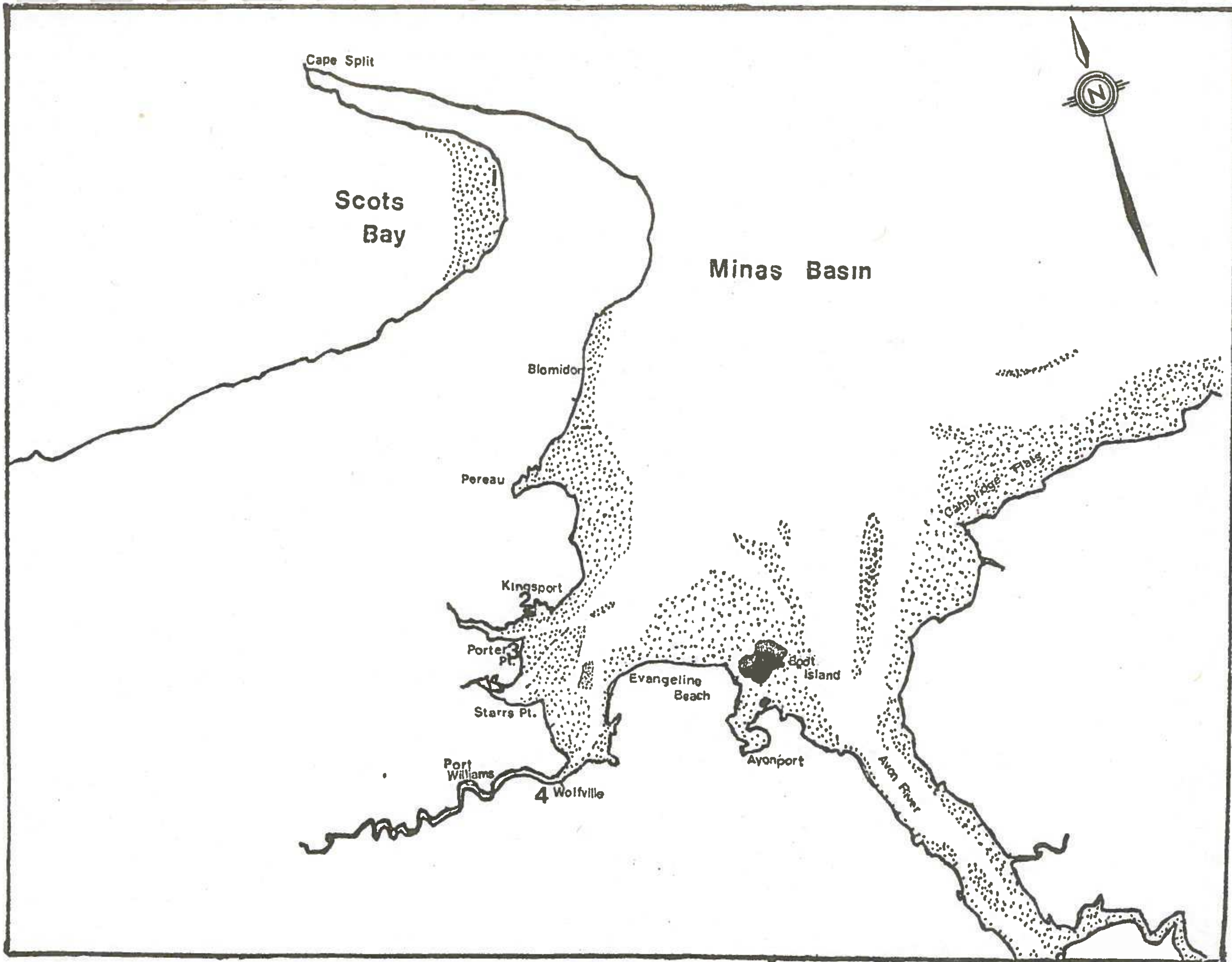

Cape Split
Scots Bay
1
Minas Basin
N
Blomidon
Pereau
Kingsport
2
Porter Pt.
3
Starrs Pt.
Port Williams
4 Wolfville
Evangeline Beach
Boot Island
Avonport
Avon River
Cambridge Flats

FIGURE 4,

3. ISOPODA

The isopods are one of the more important, yet least understood benthic crustaceans of the Minas Basin and Bay of Fundy. As a group they are generally omnivorous, and may represent important links between producers and secondary and tertiary consumers.

The Minas Basin intertidal zone is represented by four isopod species, two of which constitute the bulk of this project. *Idotea baltica* and *Idotea phosphorea* do not occur in large numbers over an entire shoreline, but have a patchy, clumped distribution which may represent a considerable portion of the total zoobiomass where they occur. This project determined the specific microhabitant occupied by both species, as well as provides information on their breeding biology and seasonal abundance.

Method

Cape Blomidon, a protected muddy to rocky beach, and Black Rock, an exposed rocky coast in the Bay of Fundy were sampled twice monthly. Thirty isopods were collected with the use of forceps from three habitants, (1) mud flats (2) in seaweed (3) under rocks, at each of the above two locations. The substrate was also sampled using an Eckman grab (15 x 15 cm). Plankton tows and dip net collections were also made at various times.

All isopods were killed in the laboratory by freezing at -15° C. The total length (distance from the tip of the cephalon to the end of the telson) and width (across the 4th thoracic segment) were recorded to the nearest 0.1 mm by using a vernier caliper.

The general breeding condition was determined and any embryos in the brood pouch were counted and the stage of development recorded.

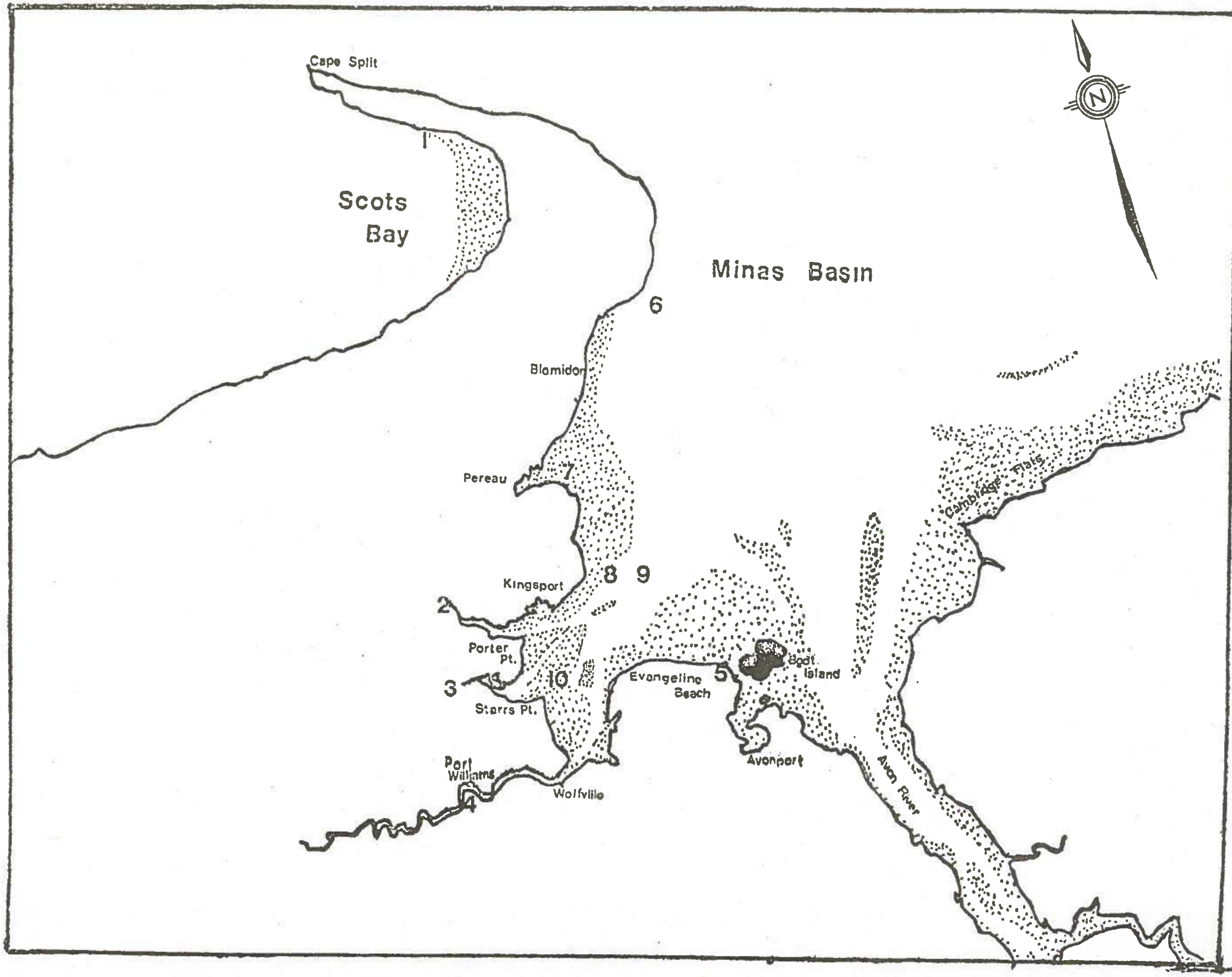
4. TEMPERATURE AND SALINITIES

I Introduction

Ten stations were established in the Minas Basin and Scots Bay area to measure temperature, salinity and conductivity. This data will hopefully lead to a better understanding of these parameters in the Minas Basin on a temporal and vertical scale. As well, comparisons can be drawn from the Minas Basin water (sta. 2-10) and the Bay of Fundy water (sta. 1). In addition, the data from sta. 2, 3, 4 (F.W. runoff streams) will be useful background information as the salinity changes on the tides most certainly affect distribution of flora and fauna in these estuaries.

II Materials and Methods

Sampling was done on a biweekly basis at all stations. Stations 1-5 were sampled on high tides and occasionally on low tides whereas stations 6-10 were sampled only on high tides. Where sufficient depth permitted, profiles were taken with readings at every 3 meters. Stations 1-5 were sampled from shore with a YSI model 33 S-C-T meter and 10 foot cable. Stations 6-10 were sampled with an Industrial Instruments Salinometer Model RS5-3 and a 50 foot cable.


Cape Split
1
Scots
Bay
Minas Basin
6
Blomidon
Pereau
7
Kingsport
8
9
2
Porter
Pt.
3
10
Starrs Pt.
Evangeline
Beach
5
Boot
Island
Cambridge Flats
Avonport
Avon River
Port
Williams
4
Wolfville
N

5. *COROPHIUM*/POLYCHAETA SUB-PROJECT

Introduction

The *Corophium*/Polychaeta sub-project was a combined study with two main objectives. The first consisted of an investigation of the growth rate and population density of *Corophium volutator*. The second objective centered around the identification, population changes and substrate relationships of various Polychaeta and Pelcypoda. These organisms are the prime food items of the hundreds of thousands of migrant shore birds that utilize the Minas Basin as their major stop-over during migrations.

For the purpose of this study, six sites were chosen; these being at Avonport, Evangeline Beach, Starrs Point, Kingsport, Blomidon Park, and Scots Bay. A transect was established at each site. A brief description of each transect follows.

Transect 1) Scots Bay - This transect begins in the sandy area below the large pebbles of the high intertidal area and is 900 m long, with 7 stations 150 m apart. The substrate of fine sand is similar for all stations.

Transect 2) Blomidon - This transect is 600 m, composed of 7 stations, 100 m apart, running from the sandy upper beach, through a muddy area at station 2, to the lower intertidal zone. The substrate of stations 3 to 7 is composed of silt and sandstone and shale fragments, which composes a layer 10-15 cm thick over the bedrock.

Transect 4) Kingsport - This transect is 500 m, with stations 100 m apart. The substrate types here, such as sand, silt-clay, silty sand, and muddy rocks are represented by the 6 stations, which run from the wharf to the low intertidal area.

Transect 7) Starrs Point - This transect is composed of 9 stations, 150 m apart, and is 1200 m in length. The substrate for all stations is similar, made up of silt over a clay layer.

Transect 12) Evangeline - This is the longest transect, 1650 m. Its 12 stations, 150 m apart, run from the sandy upper beach, through silt-clay substrates, to the sandy area of the lower intertidal zone.

Transect 16) Avonport - This transect is 900 m, with 7 stations, 150 m apart. Stations 1 and 7 are located in sandy substrate, while 2 through 6 are situated in substrate of silt and clay.

Materials and Methods

Triplicate samples were taken at each station once a month, May through July, using a 15 cm x 15 cm x 20 cm deep sampler (or a 10 x 10 x 10 cm sampler). Samples were sieved in the field through a #20 or #40 sieve (Tyler CSA sieve). Sieve contents were bottled in a 5% formalin solution. The organisms were later sorted in the laboratory and stored in 70% ethanol. Polychaetea, pelecopods, and gastropods were later identified to species and enumerated.

Samples collected in May were obtained by using the 15 cm x 15 cm x 20 cm deep sampler. Two of the samples were sieved through a #20 sieve (Tyler CSA), and one sample through a #40 sieve (Tyler CSA). Samples taken in June and July were sieved in a different manner. One sample 15 cm x 15 cm x 20 cm was sieved through a #20 sieve, and two 10 cm x 10 cm x 10 cm deep samples through a #40 sieve (CSA Tyler). The smaller sample was chosen to eliminate excessively large numbers of organisms.

Corophium from the samples were sorted into size classes.

III. RESULTS

1. GENERAL TRANSECT RESULTS

The results of the general sampling are given in table 3. Further division of the results is shown in table 4, *Corophium;* table 5, Polychaetes; and table 6, Gastropods. The numbers are all expressed in numbers/m^2. The total numbers include all the organisms in tables 4-6 and other organisms such as Nemertea and Pelecypoda.

Table 4 refers to *Corophium volutator*, the only species of *Corophium* encountered in the study.

Table 5 represents totals of all species of Polychaetes as these were not identified further. Some of the more common Polychaetes encountered were *Heteromastus filiformis*, *Spiophanes bombyx*, *Nereis virens*, *Glycera sp.*, *Clymenella sp.*, *Tharyx sp.*, and *Nephtys sp.*

Gastropods were treated in the same way as Polychaetes, lumping all of the species. However the majority of Gastropods were *Nassarius obsoletus*.

Following is a brief description of each transect and the results found. The results for each transect for each month were averaged to obtain a monthly mean density of invertebrates. This mean can be used to compare transects and to rank them according to mean densities. The rankings from lowest densities are as follows:

May	June	July
Transect 10	Transect 10	10
1	1	#1 results missing
13	13	13
6	3	6
9	9	14
11	11	5
3	6	8
15	8	11
8	15	9
5	5	15
14	14	3

Transect 1. Scots Bay

The substrate of this transect is composed mainly of sand. Invertebrate densities on this transect are second lowest of all transects. This transect would undoubtedly be even lower except for high densities of Polychaetes at station 4. Polychaetes are the major group present, with occasional amphipods encountered. *Corophium volutator* is absent with the exception of one specimen found in May.

Transect 3. Kingsport Mud Bar

The substrate of this mud bar is a mixture of silt and sand. May and June densities were low in comparison to other transects, but a large increase in July was noted. This was due to increasing *Corophium* numbers, probably young of the year. Density of Polychaetes remained fairly uniform throughout the summer.

Transect 5. Kingsport Beach

The substrate here is primarily sand (with limited amounts of silt) overlaying a base of clay. The density of invertebrates was among the highest at all transects in May and June, but dropped appreciably in July. A drop in density of Polychaetes was found in July to account for the lower total numbers. This may have been due to sampling error as many Polychaetes live in the clay which is difficult to sieve. *Corophium* is relatively rare except at certain stations.

Transect 6. Porters Point

The substrate is composed of silt and sand with a clay base. Densities are generally among the lowest of all transects except in June where an increase in numbers was noted. Polychaetes comprise most of the total, *Corophium* being rare.

Transect 8. Starrs Point

The substrate here is composed mainly of silt, in varying thickness, overlaying a clay base. Density increased from May to June, but then dropped suddenly in July. A drop in *Corophium* density was apparently the cause of lower total numbers. *Corophium* distribution is very clumped on this transect and it is possible that dense populations may have been sampled on some occasions but missed on others. Polychaeta density remains fairly constant throughout the summer. Gastropods were observed here in large numbers, but did not show up in the samples. Most were high up on the beach.

Transect 9. Starrs Point Mud Bar

The substrate here is composed mainly of silt. The changes in densities closely follow those found on transect 3, where a large increase in *Corophium* was found in July. Polychaetes show a gradual increase through the summer. Densities in July on this transect were among the highest compared to other transects.

Transect 10. Evangeline Beach West

This transect has a substrate of very little silt overlaying rock. There was little substrate to sample and hence total numbers are the lowest of all transects. Polychaetes were the dominant organisms. Distribution of organisms appeared to be clumped, possibly as the result of the uneven distribution of suitable substrate.

Transect 11 Evangeline Beach

This transect has a sandy substrate topped by varying amounts of silt. Total numbers of organisms was largely composed of Polychaetes with the exception of one station in July where a dense pocket of *Corophium* was sampled.

Transect 13. East Point

The substrate here is primarily sand. The density of invertebrates was low, comparable with Scots Bay. Polychaetes were most common in May and June, but in July *Corophium* became dominant.

Transect 14. Oak Beach

The substrate at Oak Beach is silt overlaying clay. During May and June densities were the highest of all transects. However in July a substantial decrease was noted. Gastropods accounted for the high May values, and dense *Corophium* populations accounted for the June results. Both of these groups were much lower in July. Polychaetes were most dense in May but remained fairly stable throughout the summer.

Transect 15. Avonport

The substrate at Avonport is composed of silt with a sand-gravel mixture at some stations. Densities here were among the highest of all transects. *Corophium* was most dense in July, whereas Polychaetes were most dense in June. The May results are comprised of equal numbers of both groups.

Summary.

1. Total numbers were highest at Oak Beach in May and June. Kingsport Mud Bar had the highest densities in July. Lowest densities were at Evangeline Beach west, Scots Bay and East Point for all months.

2. *Corophium volutator* is most common at Starrs Point, Starrs Point Mud Bar, Oak Beach and Avonport. The numbers of *C. volutator* were probably underestimated in July as young were evident but were perhaps too small to be retained by the sieve.

3. Polychaeta are most common at Kingsport Beach and Evangeline Beach. They were found in densities greater than $1000/m^2$ on all but 3 transects. Many populations may have been underestimated due to difficulty in sieving the clay that they live on.
4. Gastropods were common only at transect 14 in May. These results are not too accurate as many Gastropods were observed high on the beach at many locations, notably Starrs Point.

The most complete data is the species list prepared for the Minas Basin - Scots Bay areas, which gives the organism and its collection location. The tables prepared to show monthly densities give an indication of the areas with the highest densities and how they change from the month of May through to July. At this time no conclusions can be drawn from such data, but it can be used for a comparative basis should this work be continued in another year.

The short duration of this project obviously allows for only limited information to be presented. It is felt that this report should be used as a preliminary guide for more intensive studies in the future. Investigations into substrate-invertebrate relationships, insect ecology, and a closer look at densities and distributions of the intertidal species should be considered.

Transect Key to Table 2

1 - Scots Bay
2 - Blomidon
3 - Kingsport Mud Bar
4 - Kingsport Beach I
5 - Kingsport Beach II
6 - Porters Point
7 - Starrs Point I
8 - Starrs Point II
9 - Starrs Point Mud Bar
10 - Evangeline Beach West
11 - Evangeline Beach I
12 - Evangeline Beach II
13 - East Point
14 - Oak Beach
15 - Avonport I
16 - Avonport II

Other locations.

17 - Pereau Beach
18 - Selma
19 - Tennycape
20 - Black Rock

TABLE 2. MINAS BASIN - SCOTS BAY SPECIES LIST

	Transect(s) Location
PHYLUM PORIFERA	
Haliclona oculata	1, 5, 11, 13, 15, 17
Halichondria panicea	11, 17
Leucosolenia botryoicles	
PHYLUM CNIDARIA	
Tubularia sp.	
Obelia sp.	5, 17
Hydractinia echinata	1
Hydractinia valens	2
Corymorpha pendula	1
Cerianthus borealis	1
PHYLUM PLATYHELMINTHES	
Notoplana atomata	1, 11
PHYLUM NEMERTEA	
Cerebratulus sp.	2,4,7,12,16
Lineus sp.	2
PHYLUM ECTOPROCTA	
Flustra foliacea	5, 11, 18
Electra sp.	
PHYLUM MOLLUSCA	
Gastropoda	
Littorina littorea	1, 2, 5, 6, 11, 13, 17, 18, 19
Littorina obtusata	11
Littorina saxatilis	8, 11, 19
Buccinum unalatum	1, 5, 13
Buccinum totteni	1
Nassarius trivittatus	1, 5, 11, 13, 15, 17
Nassarius obsoletus	2, 6, 8, 11, 17, 18, 19
Thais lapillus	2, 5, 11, 13, 17, 19
Thais lapillus imbricatus	1, 2, 11, 18

	Transect(s) Location
Turbonilla interrupta	
Urosalpinx cinera	18, 19
Crepidula plana	11, 13
Crepidula fornicata	1, 2, 5, 6, 11, 13, 15, 17, 19
Acmaea testudinalis	1, 2, 11, 13
Lunatia heros	1, 5, 11, 13, 15, 17, 18, 19
Lunatia triserata	17
Crucibulum striatum	2
Hydrobia minuta	17
Neptunea decemcostata	1, 5
Boreotrophon scalariformes	
Coleus stimpsoni	1
Retusa pertenuis	1
Acanthodoris pilosa	11
Mitrella lunata	17
Pelecypoda	
Astarte subaequilatera	
Astarte undata	1, 2, 17
Astarte castanea	2, 5
Macoma baltica	1, 2, 5, 11, 13, 19
Mya arenaria	1, 5, 6, 8, 11, 13, 17, 18, 19
Pandora gouldina	15
Spisula solidissima	11, 17
Arctica islandica	1
Venus mercenaria	5
Venericardia borealis	2
Toldia myalis	1
Ensis directus	1, 5, 6, 11, 13, 17
Petricola pholadiformis	5, 11, 13, 15, 17, 18
Crenella glandula	
Labiosa lineata	1
Anomia aculeata	1, 2,
Mytilus edulis	1, 5, 6, 11, 17, 18, 19
Volsella demissa	13
Volsella modiolus	13

	Transect(s) Location
Plactopecten magellanicus	1
Gemma gemma	4
Loligo pectei	1
PHYLUM ANNELIDA	
Polychaeta	
Eteone heteropoda	1, 2
Nereis virens	1, 6, 11, 13, 17
Tharyx acutus	4, 7, 12
Neph tys caeca	1, 2
Glycera dibranchiata	6
Streblospio benedicti	4, 7, 12
Polydora ligni	
Pygospio elegans	
Lepidonatus squamatus	11
Heteromastus filiformes	6
Clymanella zonalis	
Clymanella torquata	
Scoloplos armiger	1
Scoloplos fragilus	1
Spiophanes bombyx	1, 2, 4
Phyllodoce maculata	17
Phyllodoce groenlandica	11
Harmothoe imbracata	11, 13
Amphitrite johnstoni	11

	Transect(s) Location
PHYLUM ARTHROPODA	
Pycnogonida	
Pycnogonum littorale	11
Crustacea	
Balanus balanoides	1, 11
Balanus sp.	
Cumacea	
Oxyirostylis smithi	2, 5, 12, 16
Eudorella truncatula	1
Diastylis sculpta	1
Isopoda	
Chiridotea caeca	2, 17, 18
Jaera marina	1, 15
Idotea balthica	2
Idotea phosphorea	20
Amphipoda	
Podoceropsis nitida	5
Phoxocephalus halbolli	5, 16
Corophium volutator	1 to 20 incl.
Gammarus oceanicus	2
Gammarus lawrencianus	
Uniciola irrorata	11, 12, 16
Psammonyx nobilis	1, 2
Ampelisca vadorum	2, 4, 16
Mysidacea	
Neomysis americana	1, 15
Decapoda	
Cragon septemspinosa	11, 17, 18
Pagarus pubescens	11, 13, 18
Cancer irroratus	1, 2, 5, 11, 13, 17
Cancer borealis	11
Carcinides maenas	1, 5
Libinia emarginata	15
Pagarus acadianus	1, 5

Transect(s) Location

PHYLUM ECHINODERMATA

Henricia sanguinolenta	2
Astarias vulgaris	1
Strongylocentrotus droebachiensis	20
Ophiopholis aculeata	

PHYLUM UROCHORDATA

Ascidiacea	
Ascidia callosa	2
Amaroucium glabrum	2
Didemnum albidum	2
Molgula citrina	2

nsect	1			2			3			5			6			8		
ation	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1							6993	4906	8259	0	6727	888	1310	2686	1008	1221	1954	289
2							3263	2864	9970	5639	8258	4085	3996	5017	4129	1421	1354	111
3							3175	1954	23199	400	3952	5506	1132	4107	3485	1687	1243	2222
4							4174	3907	16406	888	9102	1754	2309	2797	4262	1907	5128	1976
5							644	1487	821	3219	9080	7681	1154	6216	3086	6638	9080	2508
6							466	466	-	4551			3752	4862	5128	8147	2109	1798
7										5150					3397	1931	17388	6660
8										8880						5328	15607	9879
9										6638						4063	2198	8658
10										10190								6238
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
nthly mean							3119	2597	11739	4555	7423	3983	2276	4281	3499	3594	6223	4134

BLE 3. MONTHLY DENSITIES - TOTAL NUMBERS/m^2

nsect	9			10			11			13			14			15		
tion	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1	1399	1288	5306	-	0	0	-	355	3108	1576	2198	5150	15584	16361	3352	1487	7992	3086
2	6682	2420	8646	155	244	44	-	377	289	1909	1465	821	10012	2622	3397	2597	5328	7504
3	1441	2242	7348	844	44	0	888	2087	4640	999	1998	2930	6616	4706	2975	4862	7215	7637
4	2070	6660	13719	89	488	1265	2930	2087	3841	1465	1598	1288	3463	11766	3685	4784	11322	10345
5	577			466	2596	2620	1177	8081	2486				2908	8858	2464	6838	4196	7126
6	2886				400	1443	710	5217	4285				1332	1043	1976	821	11011	10634
7					2420	1310	2908	3774	5617						7881	2642	2708	15051
8							1021	2575	3508								5461	
9							1177	3041	5617								777	
10							1510	3863	2797									
11							2109	4729	5128									
12							2020	1976	3064									
13							4377	4262	9568									
14							2997	3752	3463									
15							3685	3241	6482									
16							4085	7903	1820									
17							7526	5195	6416									
18							1066	4373	14408									
19							5128	8769	4280									
20							8591	6860	11810									
thly an	2501	3152	7498	310	885	954	2995	4126	5129	1487	1815	2548	7230	7566	3676	3419	6666	8772

THLY DENSITIES - TOTAL NUMBERS/m^2

Transect	1			2			3			5			6			8		
Station	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1							0	88	7903	0	622	0	0	0		110	0	67
2							0	0	7148	0	777	44	0	0	0	0	22	0
3							44	355	20380	222	0	0	22	0	0	0	111	22
4							200	2087	15296	0	0	0	0	0	0	22	2353	111
5							400	1154	44	643	0	0	0	0	22	4862	6971	1132
6							0	22	–	0			0	0	0	289	133	0
7										0						22	13675	4507
8										0						7282	13475	5639
9										0						6527	999	7620
10										0								5417
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
Monthly Mean							107	618	10154	144	280	9	4	0	4	2124	4193	2451

TABLE 4. MONTHLY DENSITIES OF *COROPHIUM* (#/m^2)

Transect	9			10			11			13			14			15		
Station	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1	266	555	4275	0	-	0	0	-	0	67	1243	3752	4133	14452	22	311	6238	44
2	4195	733	6934	0	0	0	0	0	0	178	422	67	22	0	0	689	2731	3241
3	0	644	2975	0	0	0	0	0	22	0	844	2331	0	22	1421	977	200	4995
4	0	2731	9946	0	22	44	0	134	0	0	214	155	0	11455	1443	1443	688	9435
5	488			0	0	1843	0	0	22				22	7614	1221	4507	1621	5594
6	1820				22	89	0	22	866				220	44	355	44	8014	9191
7					0	22	0	0	0						7126	2309	2309	14430
8							0	0	0								4840	
9							0	666	89								0	
10							0	44	89									
11							0	0	0									
12							0	0	67									
13							0	0	44									
14							0	44	400									
15							0	0	133									
16							67	44	0									
17							0	0	0									
18							0	0	13431									
19							0	0	22									
20							0	0	0									
Monthly Mean	1228	1166	5900	0	7	285	4	50	760	61	681	1576	733	5598	1684	1469	2960	6704

MONTHLY DENSITIES OF *COROPHIUM* (#/m^2)

Transect	1			2			3			5			6			8		
Station	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1							6838	4507	1199	0	2753	266	1177	2686	987	289	1310	89
2							3241	2930	799	220	7082	3685	1443	2797	4063	666	1154	111
3							3108	1598	2797	110	3707	5506	1088	4107	3485	1487	1066	1487
4							3907	1399	1087	440	8591	1154	2287	2730	4240	1754	2464	1820
5							244	289	755	2420	6238	7681	1088	6149	2997	1554	2087	2198
6							422	440	-	4440			3707	5039	5106	7814	1865	1576
7										2575					3330	1887	3663	2153
8										8725						987	2131	4210
9										6371						799	1043	999
10										10101								
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
Monthly Mean							2960	1861	1327	2631	5674	3658	1798	3919	3487	1915	1865	1545

ABLE 5. MONTHLY DENSITIES OF POLYCHAETES (#m^2)

ansect	9			10			11			13			14			15		
ation	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1	1110	733	1021	0	0	0	0	355	2953	287	955	1399	3578	1776	3108	977	866	2975
2	1887	1621	2222	110	200	0	0	333	266	1421	266	733	3197	2220	3352	1865	2420	4262
3	1443	1598	4373	777	44	0	7104	1754	4418	844	844	511	2267	2908	1554	3552	6016	2642
4	2020	3929	3707	89	266	67	2287	1865	3663	1421	1177	1110	2442	222	2262	2065	10434	910
5	89			422	2531	755	932	8036	2353				2755	1154	1221	2331	2375	1487
6	1066				377	1310	666	5173	3397				932	999	1421	266	2953	1399
7					2242	1288	2886	4618	5372						755	311	400	577
8							955	2531	3419								555	
9							1177	2375	5395								733	
10							1487	3818	2708									
11							2065	4684	5062									
12							2020	1954	2997									
13							4262	4040	9524									
14							2975	3685	2997									
15							3685	3463	6305									
16							3974	7726	1053									
17							7504	5150	6416									
18							999	4329	977									
19							5128	8636	4200									
20							8658	9035	11788									
nthly Mean	1269	1970	2831				2619	4178	4298	994	811	938	2529	1547	1953	1624	3638	2036

NTHLY DENSITIES OF POLYCHAETES (#/m^2)

Transect	1			2			3			5			6		
Station	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1							155	67	0	0	44	0	133	22	44
2							0	22	0	44	22	44	1110	0	66
3							0	0	0	0	67	0	22	0	0
4							0	67	22	0	89	22	0	0	0
5							0	0	0	22	89	0	0	22	0
6							0	0	-	67	-	-	0	0	0
7													-	0	0
8															
9															
10															
11															
12															
13															
14															
15															
16															
17															
18															
19															
20															
Monthly Mean							26	26	4	51	62	13	211	6	16

TABLE 6. MONTHLY DENSITIES OF GASTROPODS (#/m^2)

Transect	8			9			10			11			13		
Station	May	June	July	May	June	July	May	June	July	May	June	July	May	June	July
1	821	644	67	0	0	0	0	0	0	0	0	0	400	0	0
2	755	178	0	0	0	0	23	44	0	0	0	23	89	400	0
3	178	67	710	0	0	0	44	0	0	133	333	200	155	244	0
4	110	311	44	0	0	0	0	200	0	644	89	1033	44	333	0
5	0	0	177	0	-	-	0	23	0	222	22	22			
6	0	89	222	0	-	-	-	0	23	44	0	22			
7	0	0	0				-	89	0	22	22	245			
8	45	0	0							66	0	89			
9	0	0	0							0	0	111			
10	-	-	0							0	0	0			
11										44	0	0			
12										0	0	0			
13										0	22	0			
14										22	0	0			
15										0	0	44			
16										22	44	0			
17										0	0	0			
18										44	44	0			
19										0	22	0			
20										67	0	0			
Monthly Mean	212	143	122	0	0	0	13	51	3	69	33	90	172	244	0

MONTHLY DENSITIES OF GASTROPODS ($\#/m^2$)

Transect	14			15			
Station	May	June	July	May	June	July	
1	7489	89	22	22	89	22	
2	6733	400	22	22	0	0	
3	4333	1776	0	333	955	0	
4	4444	89	0	1132	155	0	
5	133	44	22	0	200	44	
6	178	0	0	110	0	0	
7	-	-	0	0	0	0	
8					67		
9					44		
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
Monthly Mean	3885	400	9	231	170	9	

MONTHLY DENSITIES OF GASTROPODS (#/m^2)

2. Insect Survey Discussion

The general survey done this year was by no means a complete end in itself, but rather a way to open the door to further research.

The immediate result of the survey is an extensive collection, organised to permit some qualitative analysis (especially in the case of the wet samples), once identification is complete at least to family level.

Alongside the regular collections (as described in the methods) three special collections were made of insects in the tide.

Should the project continue in 1978, an exciting choice of possibilities is open. The Minas Basin marshes are a uniquely appropriate area for the study of tidal effects, not only on actual individuals, but likewise on population dynamics, influx of vagrants, and the almost unstudied phenomenon of dispersion by tide of resident species.

A fair number of parasitoid Microhymenoptera were collected which would provide a worthy study in itself, along with parasitism-pathology in general, as compared to counterpart land population.

The enormous insect and arachnid population of the salt marsh certainly plays a major ecological role, which needs much further investigation. Topics include insect predation and interaction of insects with other residents (arthropod and other).

The survey is already raising more questions than it is answering, and as more data becomes available, additional topics will emerge calling for specific investigation.

TABLE 7. SCOTS BAY INSECT LIST (CLASSIFICATION FOLLOWS BORROR AND DELONG)

	Family	Comments/Observation
Subphylum Chelicerata		
Class Arachnida		
Order Acari	Unidentified	Several groups amply represented; no aquatic species detected
Order Araneida	Unidentified	Collected incidentally; six-seven species total
Subphylum Mandibulata		
Class Chilopoda		
Order Geophilomorpha	Unidentified	Single specimen seen (upper beach) and taken
Class Insecta		
Subclass Apterygota		
Order Collembola		
Suborder Arthropleona	Neanuridae	Several on runoff stream
	Isotomidae	In *Spartina patens*
Subclass Pterygota		
Division Exopterygota		
Order Hemiptera		
Suborder Hydrocorizae	Corixidae	Few in pools and runoff stream
Suborder Amphibicortizae	Saldidae	One taken (marsh)
Suborder Geocorizae	Miridae	About three species
Order Homoptera		
Suborder Auchenorrhyncha		
Superfamily Cicadoidea	Cicadellidae (=Jassidae)	Two species: one from denser *Spartina* (sweep samples), one from area of low and sparse vegetation
Superfamily Fulgoroidea	Delphacidae	A sparse, widely-distributed population
Suborder Sternorrhyncha		
Superfamily Aphidoidea	Aphididae	
Division Endopterygota		
Order Coleoptera	Unidentified	Aquatic larvae: Hydrophilidae
Suborder Adephaga	Carabidae	Three species, two from beach
Suborder Polyphaga		
Superfamily Staphylinoidea	Staphylinidae	One species from lower beach; another from marsh
Superfamily Elateroidea	Elateridae	Single specimen from marsh
Superfamily Cerambycoidea	Cerambycidae	*Monochamus* sp., beach driftwood line - a vagrant

	Family	Comments/Observations
Order Lepidoptera	Unidentified	Three caterpillars, sweep sample
Order Diptera	Unidentified	A few larvae
Suborder Nematocera	Unidentified	Obtect pupee and skins
Superfamily Tipuloidea	Tipulidae	One specimen with a mite (Acari) attached; relationship unknown)
Superfamily culicoidea	Chironomidae	Well represented - at least five species
Superfamily Mycetophiloidea	Scatopsidae	From beach and marsh
Suborder Brachycera		
Superfamily Empidoidea	Empididae	A number of species, all quite smal
	Dolichopodidae	Well represented in species and numbers
Suborder Cyclorrhapha	Unidentified	Puparia
Division Aschiza		
Superfamily Syrphoidea	Syrphidae	
Division Schizophora		
Section Acalyptratae		
Superfamily Tephritoidea	Otitidae	Three species; exceedingly common in marsh
Superfamily Sciomyzoidea	Coelopidae	One taken - beach
Superfamily Lauxanioidea	Chamaemyiidae	
Superfamily Milichioidea	Sphaeroceridae	Breed in mud substrate at driftwood line
Superfamily Chloropoidea	Chloropidae	
Section Calyptratae		
Superfamily Muscoidea	Anthomyiidae	Exceedingly common, especially at driftwood line
Order Hymenoptera		
Suborder Apocrita		
Superfamily Ichneumonoidea	Braconidae	Two species, marsh-sweeps
	Ichneumanidae	Two species, marsh-sweeps
Superfamily Chalcidoidea	Eulophidae	Marsh-sweeps
	Eupelmidae	Two species, marsh
	Pleromalidae	Marsh-sweeps
	Eurytomidae	Beach (driftwood line)
Superfamily Proctotrupoidea	Platygasteridae	A minute, wingless form
Superfamily Scolioidea	Formicidae	Two species from beach

3. ISOPODA

Habitat and Distribution.

Idotea baltica This isopod was found at both Blomidon (protected shore) and Black Rock (rocky shore) in the same area - under and in fronds of the brown algae *Ascophyllum nodosum*. It is not found in every patch of this rockweed, only those clumps which did not have reproductive sacs and which were located in the lower intertidal zone. A direct relation exists between position onshore and isopod abundance; most isopods being located near ELWN, and thinning in numbers on either side of this. These isopods have a clumped distribution, one patch of rockweed may contain 8-10 isopods, the adjacent clump may contain none. This presented great difficulty to quantitative sampling procedures. Females tended to remain near the base of the clump, whereas males often were located crawling about the ends of the fronds.

Early in the season (April 27) this species was found under stones at Blomidon. These were probably overwintering adults that had migrated back to the intertidal area and had not yet established their proper habitat.

Idotea phosphorea This isopod was found under stones that were not sitting in mud - i.e. the bottom of the stone was almost completely free of mud and sand. These stones were invariably located near the MLWS area, and were only accessible on the tides <1.5 feet above datum. It was not located at Black Rock with any regularity. It also had a clumped distribution, some rocks containing several isopods while others had none. Some *I. phosphorea* were located in *Ascophyllum* early in the year, but the population quickly moved to the habitat beneath stones.

Jaera marina This isopod was not studied *per se*, but field observations indicated that it occupied both the underside of stones as does *I. phosphorea* as well as the fronds of *Ascophyllum nodosum* as does *I. baltica*. It is not found under stones partly buried in mud or sand.

Chiridotea caeca This isopod was also not well studied but appeared to occupy the mudflat surface of the higher intertidal zone, with a more random distribution than the other three species.

Seasonal Changes in Numbers

This aspect of the study was difficult to quantify, as small populations such as those at Blomidon and Black Rock tend to suffer from the impact of sampling. Table 8 shows the number of isopods calculated per 10 kg/rockweed over the summer. Gradually decreasing numbers may, however, represent the effect of oversampling.

Breeding Biology

Tables 9-10 show the numbers of female isopods in various reproductive phases over the season. The following guide will explain the developmental stages.

immature - no oöstegites or oöstegite buds, generally smaller females.

oöstegite buds- smaller flap like precussors of the oöstegites, signifying that on the next moult the females will be ready to breed.

stage I - fertilized egg stage - embryo spherical - centrally placed yolk - all ...

stage II - outer membrane ruptured - embryo a curved cylindrical shape, yolk in ventral position, segmentation obvious.

stage III - appendages present without any setae, second membrane ruptured, abundant yolk in gut, an "obvious" isopod.

stage IV - first post embryonic stage - setae present on appendages - no yolk in gut.

empty brood pouch oöstegites present but no embryos inside.

Idotea baltica The first indications of breeding occur in middle-late may, when most of the females, upon moulting, acquired oöstegite buds, the precursors of the brood pouch. The first embryos did not occur until the end of May. Stage I embryos predominated from end-May until early July, followed by the other stages. Unfortunately, the data for late July-August were not available for this report. Lab reports indicate that appreciable embryonic development will not occur at temperatures $\leq 10^{\circ}$ C, and probably proceeds faster as the temperature increases. This may explain the relatively long period of embryonic development at stage I, as the water temperature during this time did not exceed 12° C.

Idotea phosphorea Only trends can be discussed as the numbers collected were low, the general pattern being very similar to *I. baltica*.

Sex ratio

Males of *Idotea baltica* predominated in the late spring, with the ratio steadily increasing in favour of females as the season progressed. Numbers of *I. phosphorea* are not large enough to make generalizations. The sex ratios for each collecting trip are presented in Table 11.

Figure 6. Size dist. of Idotea balthica on successive 2 week Intervals Blomidon

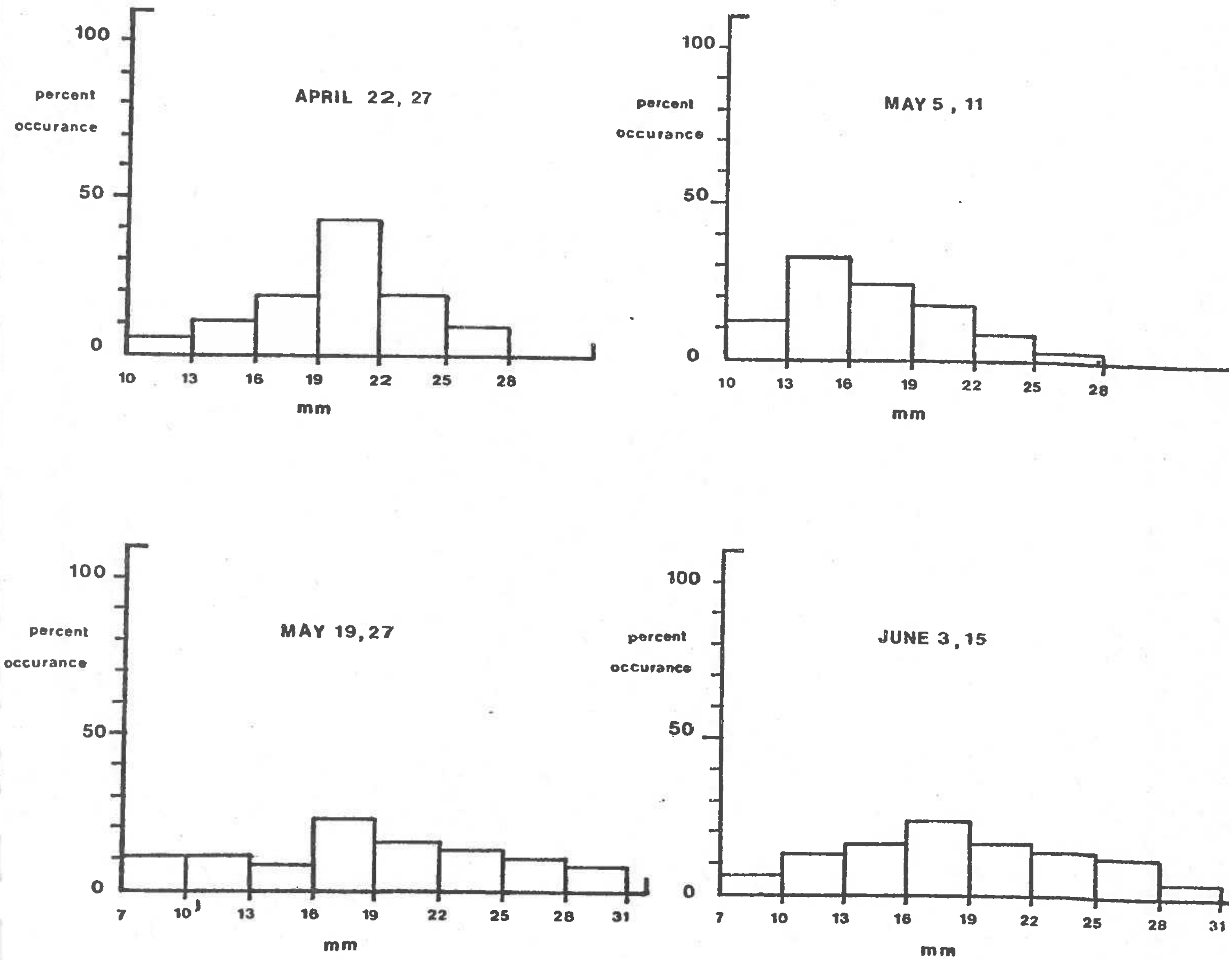
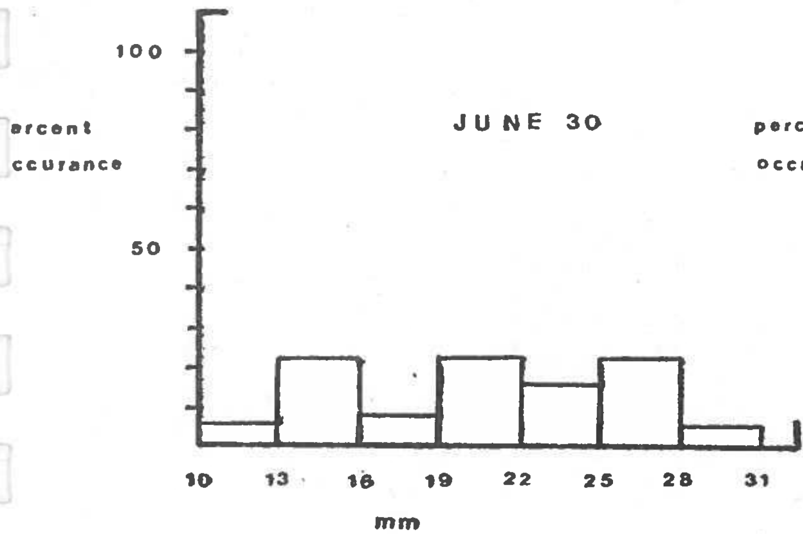


Figure 6 (cont'd.) Blomidon



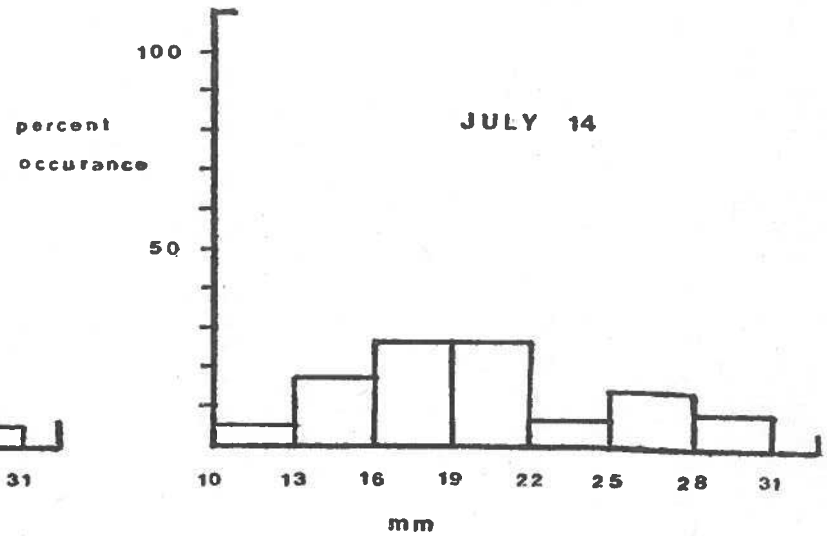


Figure 7. Size dist. of Idotea baltica. Black Rock

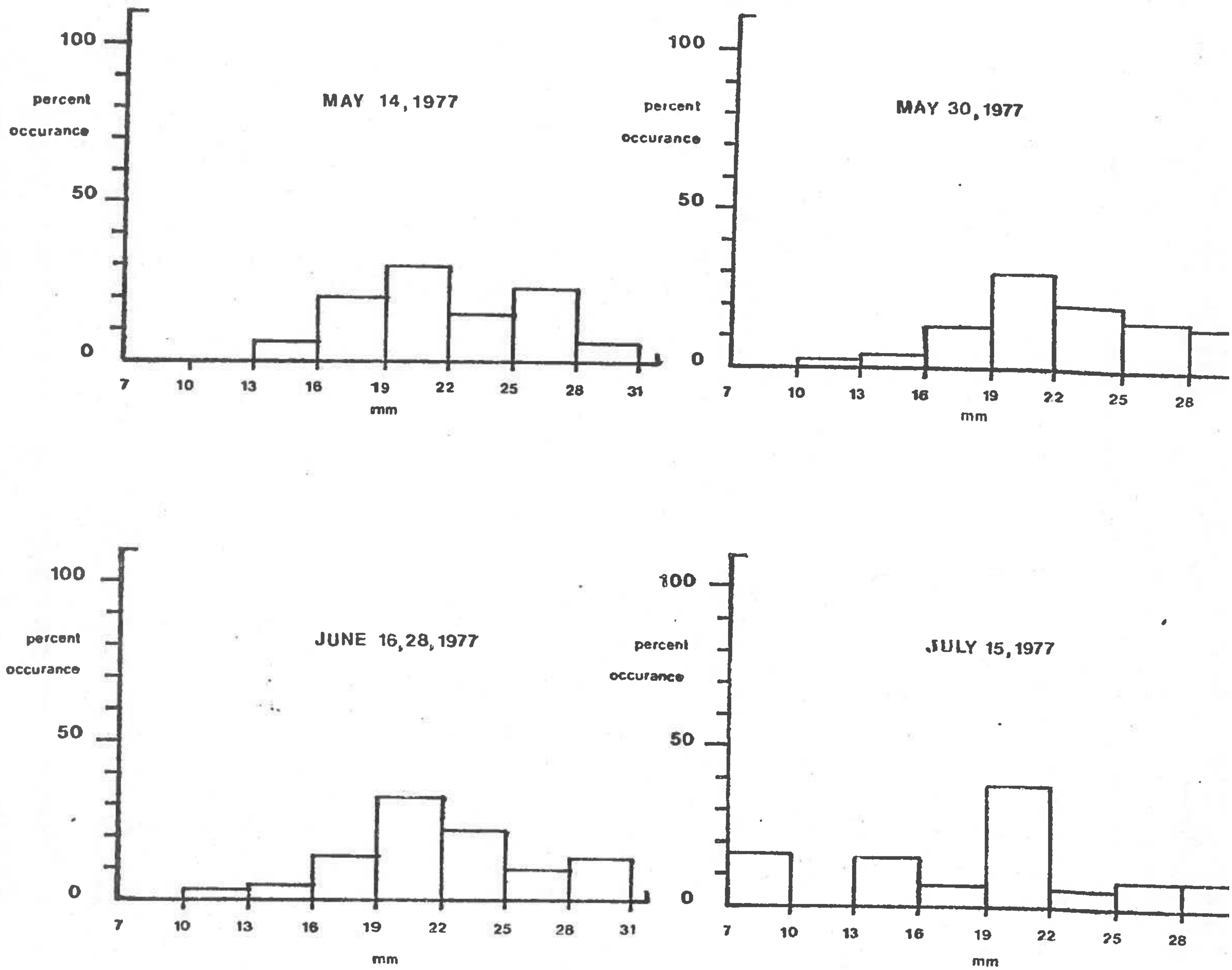


Table 8 : Abundance of *Idotea baltica* on each collecting date (numbers of isopods/10 kg. *Ascophyllum nodasum*)

DATE	LOCATION	#/10 Kg.	
14 May	Blomidon	42	
19 May	Blomidon	42	
27 May	Blomidon	44, 33	(two collections)
3 June	Blomidon	26	
15 June	Blomidon	22	
30 June	Blomidon	26	
14 July	Blomidon	11	
23 May	Black Rock	44,20	(two collections)
30 May	Black Rock	23	
16 June	Black Rock	17	
28 June	Black Rock	22	
15 July	Black Rock	13	

Table 9 : Breeding condition of Female *Idotea baltica* on each collecting date.

Date	Immature (no oöstegites)	Oostegite buds present	Fully developed brood pouch containing embryos of				
			I	II	III	IV	none
<u>Location, Blomidon</u>							
22 April	100%(6)	—	—	—	—	—	—
27 April	100%(4)	—	—	—	—	—	—
5 May	93.7%(15)	6.3%(1)	—	—	—	—	—
11 May	100%(14)	—	—	—	—	—	—
19 May	21.4%(3)	78.6%(11)	—	—	—	—	—
27 May	34.5%(10)	62.1%(18)	3.4%(1)	—	—	—	—
3 June	—	20.0%(5)	64%(16)	16%(4)	—	—	—
15 June	4.3%(1)	47.8%(11)	47.9%(11)	—	—	—	—
30 June	—	12.5%(2)	56.3%(9)	31.2%(5)	—	—	—
14 July	—	17.2%(5)	3.4%(1)	48.3%(14)	20.7%(6)	6.9%(2)	3.4%(1)
<u>Location, Black Rock</u>							
14 May	—	100%(35)					
23 May	—	82.1%(32)	12.8%(5)	—	—	—	5.1%(2)
30 May	—	64.7%(11)	35.3%(6)	—	—	—	—
16 June	—	—	77.4%(24)	19.3%(6)	—	—	3.2%(1)
29 June	3.1%(1)	—	59.4%(19)	37.5%(12)	—	—	—
15 July	—	7.7%(1)	—	46.2%(6)	38.5%(5)	7.7%(1)	—

Table 10: Breeding condition of Female *Idotea phosphorea* on each collecting date.

Location: Blomidon

Date	Immature (no oöstegites)	Oöstegite buds present	Fully developed brood pouch containing embryos of stage I	II	III	IV	none
22 April	50% (1)	——	50.0%(1)	——	——	——	——
27 April	37.5% (3)	37.5% (3)	25.0%(2)	——	——	——	——
5 May	——	——	33.3%(1)	66.7%(2)	——	——	——
19 May	50.0% (1)	50.0%(1)	——	——	——	——	——
27 May	——	25.0%(1)	75.0%(3)	——	——	——	——
30 June	——	——	8.3%(1)	16.7%(2)	75.0%(9)	——	——

Table 11 : Sex ratio of *Idotea* on each collecting date.

Date	*Idotea baltica*		*Idotea phosphorea*	
	Male	Female	Male	Female
Location - Blomidon				
22 April	60.0% (9)	40.0% (6)	81.8% (9)	18.2% (2)
27 April	85.7% (24)	14.3% (4)	80.5% (33)	19.5% (8)
5 May	67.3% (33)	32.7% (16)	72.7% (8)	27.3% (3)
11 May	66.7% (28)	33.3% (14)	100% (8)	——
19 May	54.8% (17)	45.2% (14)	80.0% (8)	20.0% (2)
27 May	48.2% (27)	51.8% (29)	——	——
3 June	47.4% (9)	52.6% (10)	28.6% (6)	71.4% (15)
15 June	47.7% (21)	52.3% (23)	——	100% (2)
30 June	56.8% (21)	43.2% (16)	——	——
14 July	48.6% (17)	51.4% (18)	——	——
Location - Black Rock				
14 May	53.3% (40)	46.7% (35)	——	——
23 May	58.1% (54)	41.9% (39)	——	——
30 May	63.3% (31)	36.7% (18)	50% (1)	50% (1)
16 June	29.3% (12)	70.7% (29)	——	100% (1)
29 June	32.7% (16)	67.3% (33)	50% (1)	50% (1)
15 July	25.0% (5)	75.0% (15)	100% (1)	——

4. Salinity and Temperature Results

The Scots Bay station (#1) has lower temperatures, higher salinities, and higher conductivities than stations 2 to 5 on the shores of the Minas Basin.

A vertical profile of temperatures at designated depths were taken at stations 6 to 10 in the Minas Basin. No thermocline was found, however temperatures, salinities, and conductivities did increase from May through to July. This study is being continued to gather additional information during late summer and the autumn.

The main factors influencing the above data are (1) the discharge rate of fresh water, (2) the extensively exposed intertidal flats that warm during low tide and cause the warming of the incoming tide, (3) the tidal volume which flows in and out of the Minas Basin.

As more detailed information becomes available, it will be reported.

TABLE 1[illegible]: TEMPERATURE, CONDUCTIVITY AND SALINITY DATA TAKEN AT HIGH TIDE

Location:	Blomidon			Delhaven			Longspell Point			Evangeline Channel			Starrs Point		
Station:	6			7			8			9			10		
Depth	cond. UMHOS	temp. (^{o}C)	sal. 0/00	cond. UMHOS	temp. (^{o}C)	sal. 0/00	cond. UMHOS	temp. (^{o}C)	sal. 0/00	cond. UMHOS	temp. (^{o}C)	sal. 0/00	cond. UMHOS	temp. (^{o}C)	sal. 0/00
<u>May 31</u>															
0-1 m	32.0	8.6	29.5	32.2	9.1	29.3	33.1	10.2	29.2	32.2	9.2	29.2	33.0	10.3	29.2
3 m	31.7	8.1	29.6	32.2	9.1	29.3	33.0	10.1	29.2	32.1	8.9	29.4	32.8	10.1	29.2
6 m	31.6	7.9	29.7	32.1	8.8	29.3	32.9	10.0	29.4	32.0	8.8	29.4	32.8	10.0	29.3
9 m	31.6	7.8	29.7				32.6	9.7	29.4	32.0	8.7	29.4	32.8	9.9	29.3
12 m	31.6	7.8	29.8												
<u>June 14</u>															
0-1 m	33.5	10.7	29.2	33.4	11.8	28.6	33.9	11.4	29.1	33.3	10.9	28.9	33.7	11.4	28.8
3 m	33.7	9.4	29.5	33.3	10.8	28.9	33.8	11.4	29.1	33.1	10.7	28.9	33.6	11.2	28.9
6 m	33.7	9.3	29.6	33.2	10.6	29.0	33.8	11.3	29.1	33.1	10.5	29.0	33.6	11.1	29.1
9 m	33.7	9.2	29.6							33.1	10.4	29.1	33.6	11.0	29.0
12 m	33.6	9.2	29.6							33.0	10.4	29.1			
14 m	33.6	9.1	29.7												
<u>July 1</u>															
0-1	34.3	11.4	29.7	35.8	14.0	29.1	35.1	13.1	29.1	35.2	13.2	28.9	35.6	13.6	29.0
3 m	34.0	10.8	29.6	34.8	12.2	29.2	35.1	12.8	29.2	35.0	13.0	29.0	35.6	13.5	29.0
6 m	34.0	10.8	29.6	34.4	11.7	29.3	35.1	12.7	29.3	34.7	12.5	29.1	35.6	13.5	29.3
9 m	34.0	10.7	29.7	34.4	11.7	29.2	35.1	12.7	29.3	34.7	12.3	29.1			
12 m	34.0	10.8	29.7							34.7	12.4	29.0			
15 m										34.7	12.3	29.2			
<u>July 19</u>															
0-1	35.9	13.2	29.6	37.2	15.2	29.2	37.8	16.2	29.2	37.5	15.8	29.2	38.0	16.9	28.9
3 m	35.8	13.0	29.7	36.7	14.6	29.2	37.3	15.5	29.2	37.0	15.2	29.3	37.6	16.1	29.1
6 m	35.7	13.0	29.7	36.4	14.1	29.4	37.1	15.1	29.2	36.9	15.0	29.3	37.5	15.9	29.2
9 m	35.7	12.9	29.7				36.9	14.8	29.3	36.7	14.7	29.3			
12 m	35.7	12.9	29.7							36.6	14.5	29.4			

TABLE 12. TEMPERATURE, CONDUCTIVITY AND SALINITY DATA TAKEN AT HIGH TIDE (YS1 MODEL 33 S-C-T METER)

Date	Stn. No.	Location	Cond.(UMHOS)	Temp (^{o}C)	Sal (0/00)
June	1	Scots Bay	33.7	11.1	29.0
June	2	Habitant	8.5	14.0	26.1
June	3	Canard	25.0	12.8	20.2
June	4	Port Williams	4.3	14.6	26.7
June	5	Evangeline	31.5	12.9	26.1
July	1	Scots Bay	35.3	13.8	29.7
July	2	Habitant	36.8	21.0	25.8
July	3	Canard	25.3	24.0	16.4
July	4	Port Williams	35.8	19.9	26.2
July	5	Evangeline	-	-	-
August	1	Scots Bay	28.5	15.0	29.5
August	2	Habitant	39.9	19.8	31.0
August	3	Canard	39.0	20.0	30.0
August	4	Port Williams	37.0	20.5	28.6
August	5	Evangeline	37.0	18.0	28.5

5. *Corophium* - Polychaeta Results

Corophium volutator (Pallas)

Corophium volutator is very abundant in a multitude of habitats in Europe (Crawford, 1937). On this side of the Atlantic Ocean its distribution is very limited, occurring only in the Bay of Fundy and along the coast of Maine (Shoemaker, 1947). The species was found by Bousfield and Leim (1960) to be the dominant intertidal inhabitant on mud and sandy-mud substrates throughout the Minas Basin.

Densities of *Corophium* varied greatly over the transects of this portion of the project (Table 14).

At Scots Bay, transect 1, only one specimen of this species was found in the three months studied.

At three other beaches, Blomidon, Kingsport and Evangeline, transects 2, 4 and 16, respectively, the density of *Corophium* was very low. Their average densities followed the same pattern for the three months: a drop from the density in May to a low in June, with a slight increase in July.

The low densities at Scots Bay and Blomidon were possibly created by the colder water temperatures at these two beaches or by the absence of a suitable substrate, which is silt.

Although the substrate at Kingsport and Evangeline was more suitable for *Corophium*, erosion of the silt layer from May to June decreased the population to such a low density that only a slight recovery was possible in July.

The effects of erosion was highly noticeable at Starr's Point transect. Despite an increase from May to June, the density dropped in July and into August.

Corophium volutator was by far the most numerous species found at Avonport, transect 16. There the density was much greater than at the other five transects. The other transect at Avonport, 15, was also the site of greater than average densities of *Corophium*. The density of the species along the transect rose steadily from May to June to July. This pattern also occurred along a transect parallel to the present transect, approximately 15 m away which I studied for five months last year (Gratto, 1977). The densities found at that time were about four times that found this year.

The life cycle of *Corophium volutator* has been investigated in England (Watkin, 1941) although no similar detailed studies appear to have been published in North America. The summer and autumn portion was investigated at Avonport last year (Gratto, 1977). I found this portion coincided with that found by Watkin (1941). This year the cycle appears to be a month behind that found last year. The first cohort of offspring appeared in June as the small size-class, <3 mm, and dominated along almost all of the transects. This group became the medium size-class, to 8 mm which dominated in July. Data for August, which is presently being processed, indicates a predominance of the small size-class, evidence of reproduction by the medium size-class of July. If such a trend were to continue through the remainder of August samples, it would show that this year's cycle has caught up to that of the previous year.

The delay between last and this year's cycle at the beginning of the summer possibly originated from a lower overwintered population resulting from a winter which was more severe than usual, with more ice in the Basin. It will be interesting to note whether the lower populations will have any longterm effects on the ecologically-important *Corophium volutator*.

TABLE 14. DENSITIES AND SIZE CLASS OF *Corophium volütator* DURING THE THREE MONTHS STUDIED.

TRANSECT	DATE	SIZE CLASS SMALL <3mm	SIZE CLASS MEDIUM 3mm to 8 mm	SIZE CLASS LARGE >8mm	TOTAL
1	May		2		2
2	"		142	4	146
4	"	10	190	5	205
7	"	3	409	46	458
12	"	2	192	2	196
16	"	4	1410	66	1480
1	June				
2	"	12	54	27	93
4	"				
7	"	372	221	4	597
12	"	26	3	1	30
16	"	1274	393	162	1829
1	July				
2	"	7	92	2	101
4	"	1	7		8
7	"	13	306	4	323
12	"	2	46	1	49
16	"	218	2191	121	2530

Polychaeta

Several polychaete species appear important intertidally in the Minas Basin and Bay of Fundy. The most numerous polychaetes during the two months studied were *Heteromastus filiformis*, *Tharyx sp.*, and *Spiophanes bombyx*. Although no definite trends in distribution or seasonal abundance could be discerned, a brief discussion of the above species is merited.

Heteromastus filiformis

This species appears to be the most widely distributed polychaete in the Minas Basin, occurring wherever the substrate is muddy. Evangeline and Starr's Point had the highest numbers of *Heteromastus*, while Scots Bay was the only transect having no *Heteromastus*, no doubt due to the lack of suitable substrate.

Heteromastus filiformis increased in numbers from June to July. Although this may be attributed to a normal summer increase as found by Buchanan Warwick (1974) in England, the increase may be partially caused by the implementation in July of two number 40 sieves (CSA), retaining more small specimens. A general increase in numbers may be expected during the summer, with random fluctuations (Watling 1975). *Heteromastus* is an opportuntistic species in that it rapidly expands its numbers to fill a gap left by the decline in numbers of another species (Buchanan and Warwick 1974), causing random fluctuations noted by several researchers (Watling, 1975; Gratto, 1977; McCurdy, 1977).

Gratto (1977) suggests there is an inverse relationshop between *Heteromastus filiformis* and the amphipod *Corophium volutator*, with high numbers of one reflecting low numbers of the other at the same station. Further research is necessary to verify this hypothesis.

Tharyx sp.

Little is known of this species in the Minas Basin. High numbers occur in very muddy substrates, notably along the Evangeline and Starrs Point transects, *Tharyx* is a small polychaete (less than 5mm) usually retained only in the number 40 sieve. Large populations appear to occur in conjunction with high numbers of *Hetermastus filiformis*.

Spiophanes bombyx

This species appears to be limited in distribution by substrate, *Spiophanes* is a tube-building spionid, and occurs in highest numbers in fine sandy sediments, often along with *Clymenella spp.* It occurs at Scots Bay and the lower Kingsport, Evangeline, and Blomidon stations where the substrate is more sandy than muddy, and is absent from muddy stations. Perhaps the species requires sand to build its tubes.

Other Polychaetes

Nephtys caeca occurred most abundantly at Scots Bay in fine sandy substrate. However, other specimens were found in a wide variety of substrates throughout the Basin. Stopford (1951) reported *Nephtys caeca* as inhabiting clean coarse sand near the low tide mark in England.

Glycera dibranchiata is a widely distributed species in the Basin, occurring most often in muddy substrates. This may be due to the fact that *Glycera* is a deposit feeder (Pettibone, 1963) and as such requires organic debris not found in more sandy substrates.

'able 15. Densities of Polychaeta, Pelecypoda, and Gastropoda (#/m^2).

Scot's Bay (transect 1)

Station	Species	May	June	July
2	Nephtys caeca	89	165	118
	Spiophanes bombyx	--	23	--
	Retusa Obtusa	--	23	--
3	Nephtys caeca	148	212	165
	Orbina ornata	--	--	23
	Spiophanes bombyx	74	71	565
4	Nephtys caeca	341	353	329
	Spiophanes bombyx	3141	5176	3129
	Scoloplos sp.	--	94	--
	Phyllodoce mucosa	--	--	23
5	Nephtys caeca	133	188	47
	Spiophanes bombyx	44	635	--
	Orbina ornata	--	--	23
6	Nephtys caeca	--	23	23
	Spiophanes bombyx	15	--	23
	Macoma balthica	15	--	--
7	Nephtys caeca	--	23	23
	Spiophanes bombyx	--	--	23
	Orbina ornata	--	23	23
	Retusa obtusa	--	23	23

Table 15. Continued

Location Blomidon (Transect 2)

Station	Species	May	June	July
1	*Heteromastus filiformis*	--	353	306
	Etone sp.	--	165	94
	Nereis virens	--	71	23
	Macoma balthica	--	1271	447
	Cerebratulus lacteus	--	--	23
	Mya arenaria	--	47	47
2	*Heteromastus filiformis*	44	71	235
	Eteone sp.	30	--	--
	Spiophanes bombyx	400	--	--
	Nereis virens	15	--	--
	Macoma balthica	30	--	94
	Mya arenaria	--	--	47
3	*Heteromastus filiformis*	74	141	118
	Eteone sp.	74	71	212
	Spiophanes bombyx	2444	1318	--
	Spiophanes filicornis	30	23	94
	Glycera dibranchiata	15	23	--
	Peloscolex benedini	--	--	118
	Cerebratulus lacteus	--	--	23
4	*Heteromastus filiformis*	15	23	--
	Eteone sp.	--	47	--
	Spiophanes bombyx	--	94	--
	Spiophanes filicornis	--	--	71
	Nephtys caeca	15	23	94
	Clymenella torguata	--	--	47
	Exogone hebes	15	--	--
	Peloscolex benedini	--	47	23
	Macoma balthica	--	23	--
5	*Spiophones bombyx*	163	423	306
	Nephtys caeca	15	--	--
	Eteone sp.	--	--	23
	Clymenella torguata	15	--	23
6	*Spiophones bombyx*	44	118	471
	Nephtys caeca	--	--	23
	Eteone sp.	--	71	471
	Clymenella torguata	--	47	--
	Glycera dibranchiata	--	23	--

Table 15 Continued

Blomidon. Continued

Station	Species	May	June	July
7	*Spiophones bombyx*	4089	2047	2800
	Spiophones filicornis	44	23	118
	Eteone sp.	15	47	141
	Phyllodoce mucosa	15	--	--
	Clymenella torguata	15	--	23
	Lumbrineris fragilis	30	--	23
	Glycera dibranchiata	--	23	23
	Nephtys caeca	--	--	94
	Nereis virens	--	--	47

Table 15. Continued

Kingsport (Transect 4)

Station	Species	May	June
1	Glycera dibranchiata	--	23
	Nereis virens	--	23
	Macoma balthica	--	94
	Gemma gemma	--	23
	Nasarrius sp.	--	71
2	Heteromastus filiformis	1437	4423
	Nephtys caeca	15	--
	Nephtys incisa	148	--
	Glycera dibranchiata	30	71
	Eteone sp.	296	165
	Tharyx sp.	607	4706
	Clymenella torquata	15	--
	Scoloplos armiger	30	--
	Cerebratulus lacteus	15	23
	Lineus sp.	15	--
	Streblospio benedicti	--	541
	Spiophanes bombyx	--	23
	Scoloplos fragilis	--	23
3	Heteromastus filiformis	1022	1059
	Tharyx sp.	252	988
	Nephtys caeca	59	71
	Glycera dibranchiata	15	--
	Eteone sp.	104	447
	Streblospio benedicti	311	729
	Spiophanes bombyx	104	282
	Fabricia sabella	15	23
	Poldora ligni	15	--
	Turbonilla sp.	--	23
	Gemma gemma	15	23
	Mya arenaria	--	--
4	Spiophanes bombyx	755	423
	Clymenella torquata	1126	1294
	Nephtys caeca	89	94
	Glycera dibranchiata	44	--
	Eteone sp.	74	94
	Nereis virens	15	--
	Scoloplos sp.	15	--
	Tharyx sp.	--	23
	Streblospio benedicti	--	259
	Heteromastus filiformis	--	141
	Cerebratulus lacteus	--	--

Table 15. Continued

Kingsport. Continued

Station	Species	May	June
5	*Spiophanes bombyx*	711	2000
	Clymenella torquata	--	118
	Clymenella zonalis	15	--
	Nephtys caeca	30	--
	Glycera dibranchiata	15	118
	Tharyx sp.	--	23
	Phyllodoce mucosa	44	71
	Nereis virens	--	--
	Spiophanes filicornis	44	--
	Heteromastus filiformis	--	141
	Spiophanes benedicti	--	23
6	*Spiophanes bombyx*	563	1035
	Clycera dibranchiata	30	--
	Phyllodoce mucosa	15	47
	Nephtys caeca	--	47
	Nereis virens	--	47
	Syllis cornuta	--	23

Table 15. Continued

Starrs Point (Transect 7)

Station	Species	May	June
1	Heteromastus filiformis	993	1082
	Tharyx sp.	296	541
	Eteone sp.	74	165
	Scoloplos armiger	74	1106
	Cerebratulus lacteus	--	24
	Streblospio benedicti	--	24
	Nassarius obsoletus	755	2527
	Glycera dibranchiata	--	24
2	Heteromastus filiformis	518	1577
	Tharyx sp.	311	471
	Eteone sp.	133	47
	Scoloplos armiger	44	165
	Streblospio benedicti	163	165
	Nassarius obsoletus	726	894
3	Heteromastus filiformis	681	1553
	Tharyx sp.	578	847
	Eteone sp.	--	71
	Streblospio benedicti	14	188
	Nassarius obsoletus	44	--
4	Heteromastus filiformis	785	3012
	Tharyx sp.	1599	2588
	Eteone sp.	29	94
	Scoloplos armiger	--	24
	Streblospio benedicti	14	28
	Glycera dibranchiata	--	--
	Nassarius obsoletus	44	24
5	Heteromastus filiformis	592	1647
	Tharyx sp.	1037	3655
	Eteone sp.	89	235
	Streblospio benedicti	74	144
	Scoloplos armiger	14	48
	Glycera dibranchiata	--	24
	Nassarius obsoletus	14	--
6	Heteromastus filiformis	1881	2259
	Tharyx sp.	2148	4188
	Eteone sp.	98	94
	Streblospio benedicti	14	71
	Scoloplos armiger	14	23
	Glycera dibranchiata	14	71
	Nephtys incisa	42	23
	Nassarius oboletus	56	518

Table 15. Continued

Starrs Point. Continued

Station	Species	May	June
7	Heteromastus filiformis	1570	2518
	Eteone sp.	1392	2870
	Streblospio benedicti	98	94
	Scoloplos armiger	14	--
	Glycera dibranchiata	42	71
	Nephtys incisa	42	23
8	Heteromastus filiformis	1363	4047
	Tharyx sp.	4339	7930
	Eteone sp.	118	353
	Streblospio benedicti	118	376
	Glycera dibranchiata	--	71
	Nephtys incisa	--	--
	Cerebratulus lactus	14	23
9	Heteromastus filiformis	1525	6353
	Tharyx sp.	1229	4588
	Eteone sp.	133	165
	Streblospio benedicti	133	659
	Glycera dibranchiata	59	48
	Nephtys incisa	29	71

Table 15. Continued

Evangeline Beach (Transect 12)

Station	Species	May	June
2	Heteromastus filiformis	639	3741
	Tharyx sp.	1614	5530
	Eteone sp.	119	47
	Scoloplos armiger	148	400
	Glycera dibranchiata	--	71
	Streblospio benedicti	15	--
	Cerebratulus lacteus	30	--
	Nassarius obsoletus	59	24
3	Heteromastus filiformes	1022	6377
	Tharyx sp.	107	2588
	Eteone sp.	74	212
	Glycera dibranchiata	30	24
	Streblospio benedicti	15	71
	Nephtys caeca	--	235
	Lumbrineris fragilis	--	24
	Nassarius obsoletus	652	--
	Young Nephtidae	341	--
4	Heteromastus filiformes	859	6165
	Tharyx sp.	133	1082
	Eteone sp.	59	71
	Glycera dibranchicti	44	71
	Streblospio benedicti	15	71
	Nassarius obsoletus	15	24
	Young Nephtidae	89	141
	Cerebratulus lacteus	15	--
5	Heteromastus filiformis	1451	7059
	Tharyx sp.	44	447
	Eteone sp.	15	94
	Glycera dibranchiata	30	47
	Streblospio benedicti	44	188
	Cerebratulus lacteus	30	47
	Young Nephtidae	163	259
6	Heteromastus filiformis	2177	6871
	Eteone sp.	89	24
	Glycera dibranchiata	30	71
	Streblospio benedicti	15	--
	Nephtys caeca	15	--
	Clymenella torquata	--	24
	Cerebratulus lacteus	15	--
	Young Nephtidae	30	24

Table 15. Continued

Evangeline Beach. Continued

Station	Species	May	June
7	Hetermastus filiformis	1259	2377
	Tharyx sp.	104	518
	Eteone sp.	30	24
	Glycera dibranchiata	44	118
	Streblospio benedicti	--	118
	Young Nephtys	15	165
	Nephtys caeca	30	--
	Spiophanes bombyx	--	165
	Clymenella torquata	--	118
	Cerebratulus lacteus	--	24
	Unknown Spionidae	--	1365
8	Heteromastus filiormis	859	2588
	Tharyx sp.	30	118
	Eteone sp.	30	94
	Glycera dibranchiata	89	118
	Streblospio benedicti	30	282
	Young Nephtidae	163	47
	Nephtys caeca	15	118
	Spiophanes bombyx	207	635
	Phyllodoce minuta	15	--
	Cerebratulus lacteus	--	47
	Unknown Spionidae	--	1529
9	Heteromastus filiformis	370	1012
	Eteone sp.	15	--
	Glycera dibranchiata	30	118
	Streblospio benedicti	--	47
	Young Nephtidae	--	94
	Nephtys caeca	--	24
	Spiophanes bombyx	429	847
	Clmenella torquata	--	71
	Phyllodoce minuta	--	24
10	Heteromastus filiformis	681	1365
	Eteone sp.	15	71
	Glycera dibranchiata	104	141
	Young Nephtidae	59	24
	Nephtys caeca	--	71
	Spiophanes bombyx	2133	4024
	Clymenella torquata	44	471
	Phyllodoce minuta	--	24
	Cerebratulus lacteus	--	47

Table 15. Continued

Evangeline Beach. Continued

Station	Species	May	June
11	Heteromastus filiformis	118	1082
	Eteone sp.	15	94
	Glycera dibranchiata	104	188
	Spiophanes bombyx	3421	1859
	Clymenella torquata	459	518
	Phyllodoce mucosa	44	94
	Nephtys caeca	44	--
	Cerebratulus lacteus	30	--
12	Heteromastus filiformis	74	505
	Glycera dibranchiata	74	165
	Spiophanes bombyx	1155	2918
	Clymenella torquata	1185	1129
	Phyllodoce mucosa	--	24
	Nephtys caeca	89	24
	Cerebratulus lacteus	44	--

Table 15. Continued

Avonport (Transect 16)

Station	Species	May
2	Heteromastus filiformis	1289
	Tharyx sp.	193
	Eteone sp.	178
	Glycera dibranchiate	14
	Nereis virens	30
	Scoloplos armiger	74
	Cerebratulus	14
3	Heteromastus filiformis	1733
	Tharyx sp.	89
	Eteone sp.	104
	Scoloplos armiger	44
4	Heteromastus filiformis	415
	Spiophones filicornis	14
	Nephtys caeca	14
	Eteone sp.	14
	Macoma balthica	44
5	Heteromastus filiformis	222
	Nephtys caeca	30
	Eteone sp.	14
	Clymenella zonalis	59
6	Heteromastus filiformis	163
	Nephtys caeca	59
7	Heteromastus filiformis	14
	Nephtys caeca	14
	Spiophanes bombyx	14

Report on Ascidians of the Minas Basin

(August 1977)

Introduction

Although ascidians form a conspicuous part of the littoral fauna on the southeast shoreline of Cape Blomidon, their overall intertidal distribution in the Minas Basin has probably been limited by the unavailability of suitable substrate. Ascidians are primarily colonizers of submerged rocks, wharfs, and pilings found within the littoral zone. They have been reported from Kingsport and adjacent Longspell Point but findings are extremely rare at these localities. No additional sites were discovered by our field crews who surveyed much of the West Minas Basin in 1977.

The lower littoral zone at Cape Blomidon south consists of long, sandstone terraces separated by tide pools 15-30 cm deep. Within these tide pools are the basalt rocks which provide suitable substratum for a variety of life forms including ascidians; the colonial forms *Amaroucium glabrum* and *Didemnum albidum*, and the solitary species *Ascidia callosa* and *Molgula citrina*.

This report includes notes on the breeding season, growth rates, and associations from data collected in April, May, June, July and August of 1977. It should be understood that all data is preliminary and because of time limitations the quantitative data on growth rates could not be analysed to be included in this project.

Materials and Methods

Field

Cape Blomidon was visited on a monthly basis in accordance with extreme low water spring tides, usually 3-5 field trips on consecutive days. Equipment consisted of two buckets, numbered jars, spatula, clipboard and Gestetner acetate sheets, thermometer, two cameras; a Kodak Ekman Copy camera with 3 x 3" and 8 x 8" copy stands, and a Konica 35 mm and an ice chest carrying replacement slides and slide boxes. Three to four persons were actively involved on these field trips.

In late May three cement blocks were dropped on the study site from a boat at high tide. On the first field trip in early June two of these blocks were positioned in two tide pools, designated A and B. (Figure 1 depicts the general area and one block is visible in centre foreground.) ( ) Omit In August the blocks were elevated because of sand accumulation and the block formerly in tide pool A was repositioned in tide pool B. Each block contained four 8 x 11 cm slide boxes with eight slides per box. Four of the eight slides were roughened with carborundum paper. The rough and smooth slides were placed back to back so only one surface per slide was exposed. The slides were stationed horizontally within their respective blocks. A record of each month's growth was kept by replacing four slides per block. With the exception of the first month (June) two slides were removed from the blocks each month. Thus the two slides collected in late August had been submerged for 3 months. Slides were brought back to the lab in an ice chest.

A hammer and chisel were used to mark six rocks. Ascidians located on these rocks were photographed monthly using the Kodak Ekman and Konica 35 mm cameras to determine growth rates. A section of a mm scale with attached date was placed in the field of view of each picture as a standard reference for measurement. Collections, randomly chosen, were carefully scraped from rocks adjacent to the study area and placed in numbered jars.

Incidence of association with other organisms was prepared from observations made on thirty-five rocks.

Laboratory

Slides within the ice chest and numbered jars containing specimens were placed in a lab refrigerator cooled to a few degrees below the average monthly temperature recorded in the Minas Basin. Slides and specimens were examined using a Wild M-5 Stereomicroscope. Representative specimens of each species were dissected to determine the condition of the gonads, and to record the presence of embryos and tailed larvae. Where difficulty was encountered concerning the condition of the gonads, sections of specimens were sectioned at 7 μm and stained with Ehrlich's Hemotoxylin and Eosin.

Several methods for narcotizing ascidians were employed. The most satisfactory method consisted of an equal volume of sea water and isotonic magnesium sulphate. Samples were fixed in 5% formalin or Bouin's marine.

The culture methods used throughout the summer were modified from those summarized by Galtsoff (1937) and Costello (1957). The aqua chiller temperature and salinity were adjusted to match those present at Cape Blomidon, and the filter was removed to allow free flow of plankton. Nutrients were added and a base of sand taken from Cape Blomidon was introduced to the bottom of the tank. Culture vessels were prepared by fusing the top and bottom of petri dishes with silicone cement and then cementing the bottom of the syracuse watch glass to the bottom of the petri dish. This enabled the syracuse watch glasses to float inverted on the surface of the water. Representative tailed larvae were placed in individual water droplets to facilitate attachment. When attached these larvae were placed in the aqua chiller.

Results and Discussion

a) Breeding Season

Breeding in ascidians takes two main forms. Asexual reproduction or budding in some families, and sexual reproduction or breeding which occurs universally throughout the group.

Within the class ascidiacea the breeding is primarily a function of temperature. With the onset of spring, the temperature in the Minas Basin rises, and as soon as embryonic and larval stages can survive, breeding commences.

i) Sexual Reproduction

Breeding (judged by the presence of tailed larvae either expelled or within the atrial chamber) was examined in *A. callosa*, *A. glabrum*, *D. albidum*, and *M. citrina* from April through to August. Results are summarized in Figs 8-12.

The breeding of *A. callosa* is represented by Fig. 8. It is assumed sampling has been representative. The two primary conditions governing sexual reproduction are specimen size and temperature. Although collection size is small a simple pattern is noted. In April the sea temperature is too cold for breeding to occur. As the temperature increases in May and June breeding commences in specimens >14 mm in length. The exact relationship between size and breeding condition is difficult to determine due to small sample size and the relatively large error introduced in measurement. Breeding continues throughout June and July but stops altogether at or near the 1st of August. At this time it is not known if breeding will begin again in August or if the optimum temperature range for breeding has been exceeded. Sampling in late August should provide an answer to this question.

Sexual reproduction in *M. citrina* during the spring and summer months is similar to *A. callosa* as illustrated in Fig. 9. Obviously there is a disadvantage in representing graphical data according to size groups of adults, when sample sizes are small, and a more valid indication of the resemblance is indicated by lumping the data as shown in Fig. 10. Nevertheless the interpretation of Fig. 9 is as follows. The cool sea temperature in April inhibits breeding which begins as temperature rise in May, June and July. Breeding reaches a peak in July and continues throughout the summer. Again there is a reduction in early August.

Breeding in colonial forms does not coincide with the breeding pattern exhibited by solitary forms. Sexual reproduction in *A. glabrum* is exhibited in Fig. 11 and is illustrated in *D. albidum* in Fig. 12. In both colonial forms breeding commences in early July and reaches a peak in late July. The general colonial structure of *A. glabrum* between the months of April and August has been observed. In April the zooids are relatively small (no long post-abdomen) and the buds are dormant. During May and June the buds elongate and mature. The blastozooids are breeding by the first of July and continue to breed throughout the summer. There is tremendous reproductive variation between and within *A. glabrum* and *D. albicum* colonies. Colonies of the same size and having similar zooid structure may be packed with tailed larvae or contain none at all.

ii) Asexual Reproduction

The reproductive activity is further complicated in colonial forms by asexual reproduction or budding. Although data concerning asexual reproduction is incomplete the pattern in *A. glabrum* seems evident. During winter *A. glabrum* colonies degenerate and in most cases become a mass of dormant blastozooids. The blastozooids mature in spring and elongate until a very lengthy post-abdomen is visible. This post abdomen eventually strobilates with each section forming a new individual. Thus asexual reproduction is primarily a fall and winter phenomenon with some activity occurring in spring and summer. Budding in *D. albidum* has not been observed.

b) Growth Rates

To date growth rate studies have been rather unsuccessful. Three methods have been employed:

(i) *in situ* photographs

(ii) culturing of expelled tailed larvae in aqua chiller

(iii) placing glass slides anchored in cement blocks within the study site.

(i) Photographs of animals *in situ* give only a monthly indication of rates of growth since ascidians are only accessable at E.L.W.S. This method was primarily used for colonial forms. Body length was used to indicate the size of solitary species.

From the compilation of monthly photographs some qualitative patterns have been observed. The most obvious are found in colonial forms whereby monthly periods show sections of *A. glabrum* colonies regressing or colonies of *D. albidum* degenerating or disappearing. Two *A. callosa* specimens observed in June 1976 were present in July but had disappeared in September 1976. Another *A. callosa* on the same rock located in June 1976 was present in November but had disappeared when the rock was observed in February 1977.

Interpretation of quantitative data has not been completed.

To complement monthly sampling and photographic procedures methods (ii) and (iii) were engaged.

(ii) Attached larvae were placed in the aqua chiller but metamorphasis progressed very slowly. Over a two month period *Molgula citrina* tailed larvae grew to 0.5 mm in diameter. It is impossible at this time to tell whether larvae naturally develop slowly or a specific environmental parameter is missing. The latter, however, seems more likely.

(iii) Replacement slides from June and July contained various fouling organisms such as ectoproct, hydroids and foraminifera but yielded no ascidia tailed larvae. The slides removed after two months submergence contained hydroids, ectoprocts, entoprocts and foraminifera at later stages of development but contained no tailed larvae.

Associations

During June, July and August sampling times, epibiotic associations were recorded to supplement predator-prey relationships. The occurrence of species associated with ascidians is summarized in Table 1.

i) Fouling associations

Most ascidian associations are probably coincidental. Fouling organisms (i.e. algae, barnacles, ectoprocts, entoprocts, hydroids, sponges, ascidians, etc.) are constantly competing for space. It is of no surprise to find *A. glabrum, D. albidum, A. callosa,* or *M. citrina* growing on or amongst these organisms. *A. glabrum* is the most successful species of ascidian at Cape

Blomidon. It is found on the top, sides or bottom of rocks growing on or over most fouling organisms. *A. glabrum* is commonly found growing on or surrounding such species of algae as *Ceramium* sp. *C. officinalis*, *Enteromorpha* sp., *G. stellata*, *L. longiculis*, *Lithothamnion* sp. and the ectoprocts *F. foliacea* and *Electra* sp. Its dense clumps also cover barnacles. *A. glabrum* provides a surface for amphipods and polychaetes to cling to and often their burrows are attached to its exterior. Although *D. albidum* can be found among the fouling organisms it is generally isolated. Its fouling associates include the algae *Enteromorpha* sp. *C. officinalis* and the ectoprocts *F. foliacea*. The solitary species *A. callosa* and *M. citrina* are normally found on sections of rock void of most fouling organisms except barnacles. Their tests do provide, however, a suitable substrate for hydroids, ectoprocts, entoprocts and the attached forms of scyphozoa such as scyphistoma. One less common association found in the field was *Halichondria panicea* growing on the surface of *A. callosa*.

ii) Interspecific and intraspecific associations

It is not uncommon to find two species of ascidians fused at their borders and virtually all twelve possible combinations of the four species have been observed. Although this association is not understood it could hardly be viewed as beneficial. Ascidians are filter feeders and close proximities with other filter feeders, at times when food sources are scarce, would be detrimental to their existence. The extent of these associations are variable. Colonial forms have been observed to completely surround solitary forms. In one case *A. glabrum* had grown over *M. citrina* to such an extent only the siphons were visible. On another occasion *D. albidum* was observed to completely surround *M. citrina*.

Intraspecific associations are also prevalent. Such associations within colonial forms (i.e. a colony and its daughter colony) would be difficult to determine and as yet have not been noted. Intraspecific linkages within solitary forms are common. In the field it is rare to find a *M. citrina* singly on a rock. This same pattern holds true for *A. callosa,* although to a lesser extent.

<u>Predators</u>

Predator-prey relationships are difficult to prove within the ascidiacea. Normally one examines stomach contents of suspected predators but since few parts significantly withstand digestion (spicules and in some species the tests are exceptions) to be identified few records of such relationships exist (Miller *et al* 1971).

Suspected predators of *A. glabrum* and *D. albidum* are the polychaete *Lepidonatus squamatus,* the gastropods *Thais lappilus* and the echinoderm *Asterias vulgaris.* The solitary forms provide the best evidence of predator-prey relationships. *A. callosa* placed in aquaria have been attacked by *Asteria vulgaris.*

In the field *Asterias vulgaris* has often been found close to *A. callosa* and in one case was observed adjacent to a punctured *A. callosa* which was void of internal organs. No other possible predators were noted on the rock. Scyphistoma attach to both *M. citrina* and *A. callosa* and have been observed feeding on *M. citrina* tailed larvae.

<u>Parasites or Commensals</u>

Copepods of the family Notodelphyid have been observed within the test of *A. glabrum.* Whether this association is parasitic or commensal is not known.

SUMMARY

1. Four ascidians *Amaroucium glabrum, Didemnum albidum, Ascidia callosa* and *Molgula citrina* are commonly found on the southeast shoreline of Cape Blomidon, Minas Basin.
2. Breeding in ascidians consists of two main forms: sexual and asexual and sexual reproduction is primarily a function of temperature.
3. Breeding in *A. callosa* and *M. citrina* commences in June and continues throughout the summer with a reduction in early August.
4. Breeding in the colonial forms *A. glabrum* and *D. albidum* commences in July and continues throughout the summer reaching a peak in late July.
5. Asexual reproduction *A. glabrum* takes place primarily in the fall and winter although it seems more asexual activity continues through the summer. Asexual reproduction in *D. albidum* has not been observed.
6. *In situ* photographs show monthly periods of regression in *A. glabrum* and monthly cycles of degeneration or disappearance in *D. albidum.* Many adult specimens of *A. callosa* disappear in fall and winter - a probable indication of senescence and death.
7. *A. glabrum* is the most successful species at Cape Blomidon.
8. Interspecific and intraspecific associations are common.
9. Suspected predators of *A. glabrum* and *D. albidum* are *Lepidonatus squamatus, Thais lapillus,* and *Asterias vulgaris.*
10. *Asterias vulgaris* was observed preying on *A. callosa.*
11. Parasitic or commensal copepods from the family Notodelphyid were found within *A. glabrum.*

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Table 16. Summary of species occurrence associated with ascidians

Species	Occurrence: Rare	Common	Abundant
<u>Algae</u>			
Corallina officinalis			X
Enteromorpha sp.	X		
Gigartina stellata			X
Laminaria longicuris		X	
Lithothamnion sp.			X
Ulva lactuca	X		
<u>Ectoprocta</u>			
Electra sp.		X	
Flustra foliacea			X
<u>Porifera</u>			
Halichondria panicea			X
<u>Polychaeta</u>			
Amphitrite sp.	X		
Lepidonatus squamatus		X	
<u>Crustacea</u>			
Balanus sp.			X
Crangon septemspinosa		X	
Idothea		X	
Pagurus	X		
<u>Mollusca</u>			
Littorina Littorea			X
Crepidula sp.			X
Thais lapillus			X
Ischnochiton sp.	X		
<u>Echinodermata</u>			
Asterias vulgaris		X	

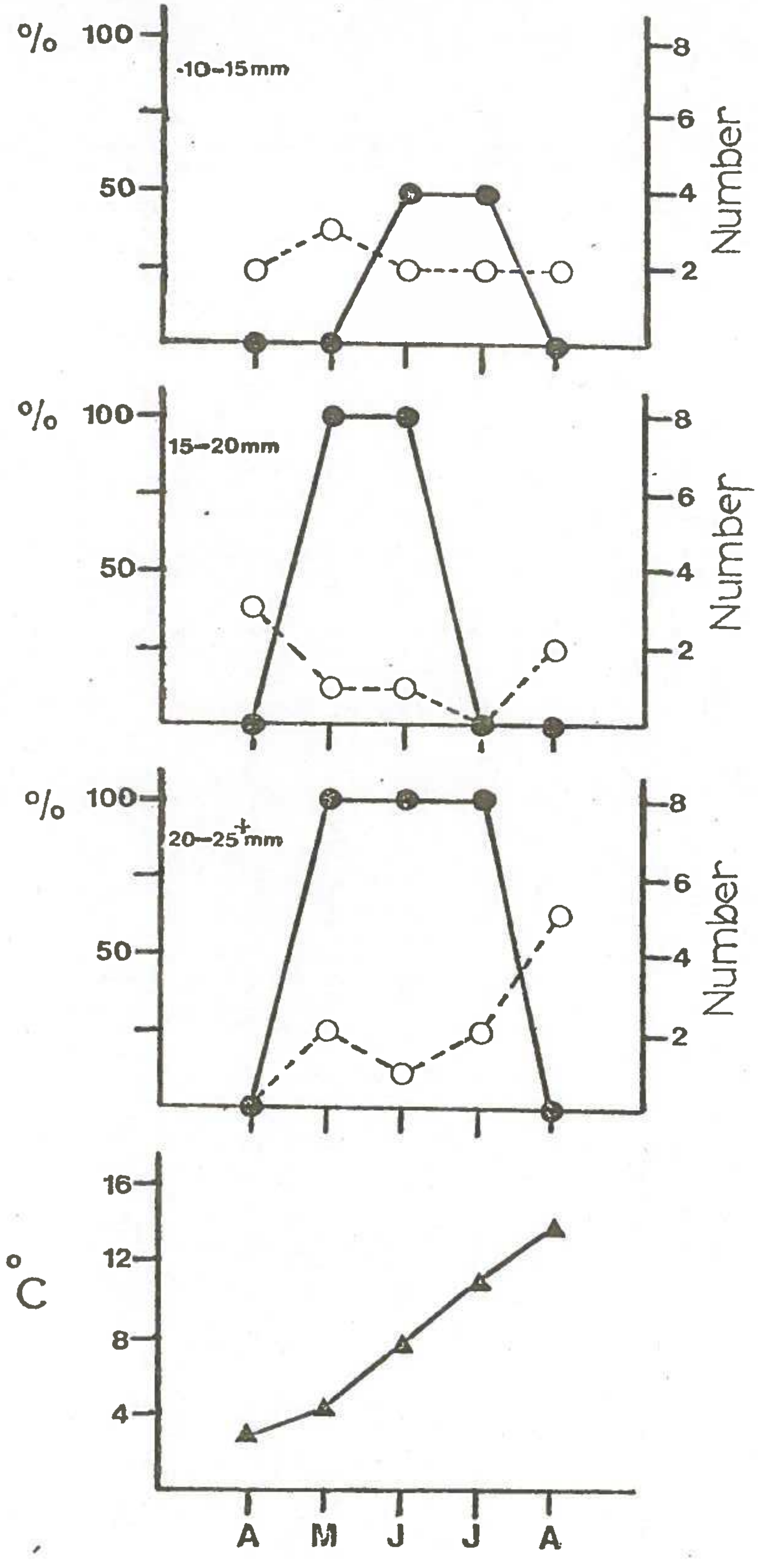

Figure 8. Summer reproduction in *Ascidia callosa*. Percentage of collections with incubating or expelled tailed larvae, in different size groups of adults, ●—●. Number of collections within size range indicated O– –O. Sea temperatures at Cape Blomidon ▲—▲.

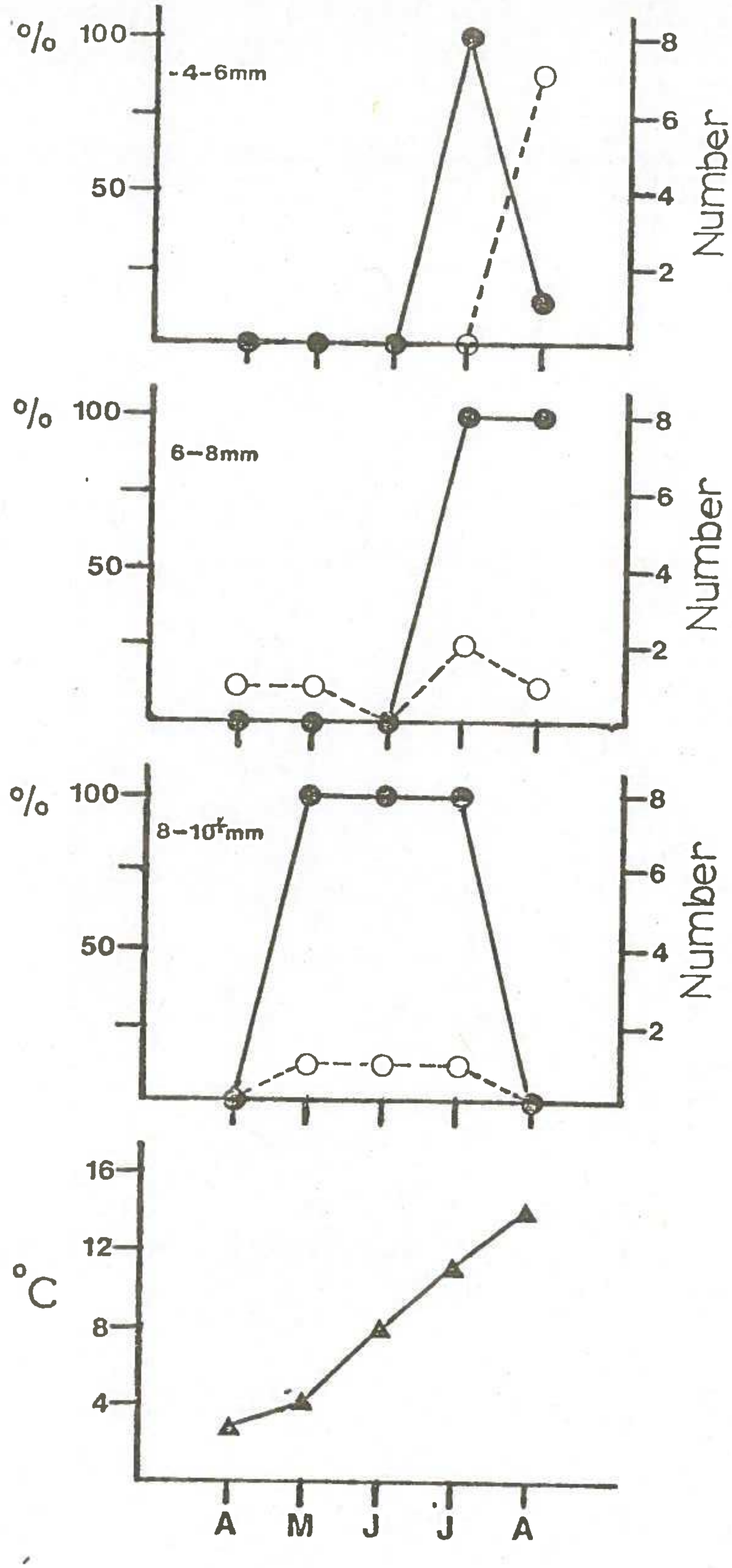

Figure 9. Summer reproduction in *Molgula citrina*. Percentage of collections with incubating or expelled tailed larvae, in different size groups of adults, ●—● . Number of collections within size range indicated O--O . Sea temperatures at Cape Blomidon ▲—▲ .

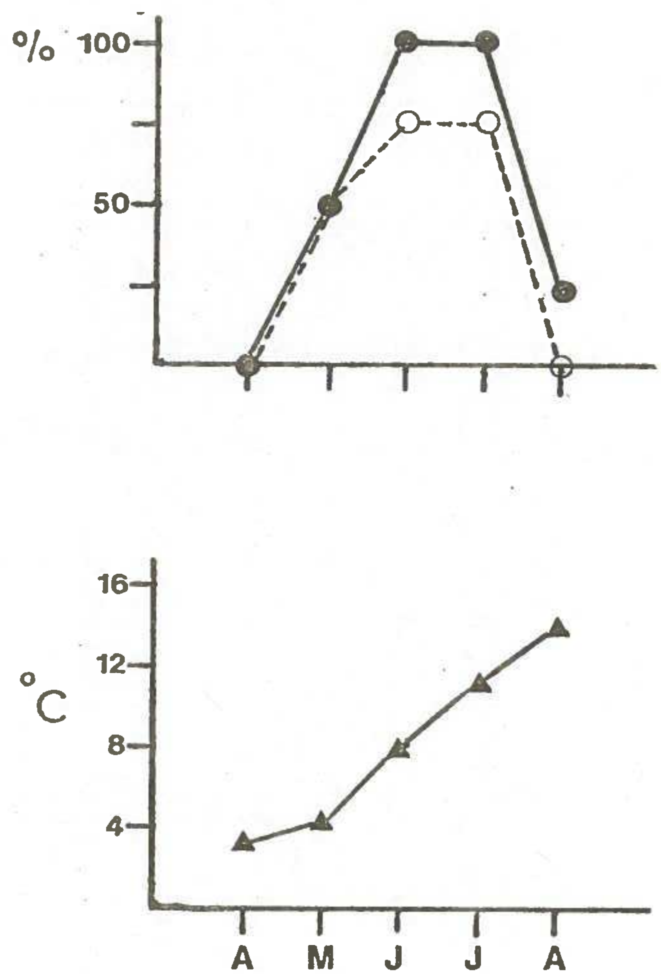

Figure 10., Summer reproduction in *A. callosa* and *M. citrina*. Percentage of collections of *A. callosa* with incubating or expelled tailed larvae, 0 — — 0. Percentage of collections of *M. citrina* with incubating or expelled tailed larvae, ●—●. Sea temperatures at Cape Blomidon ▲—▲.

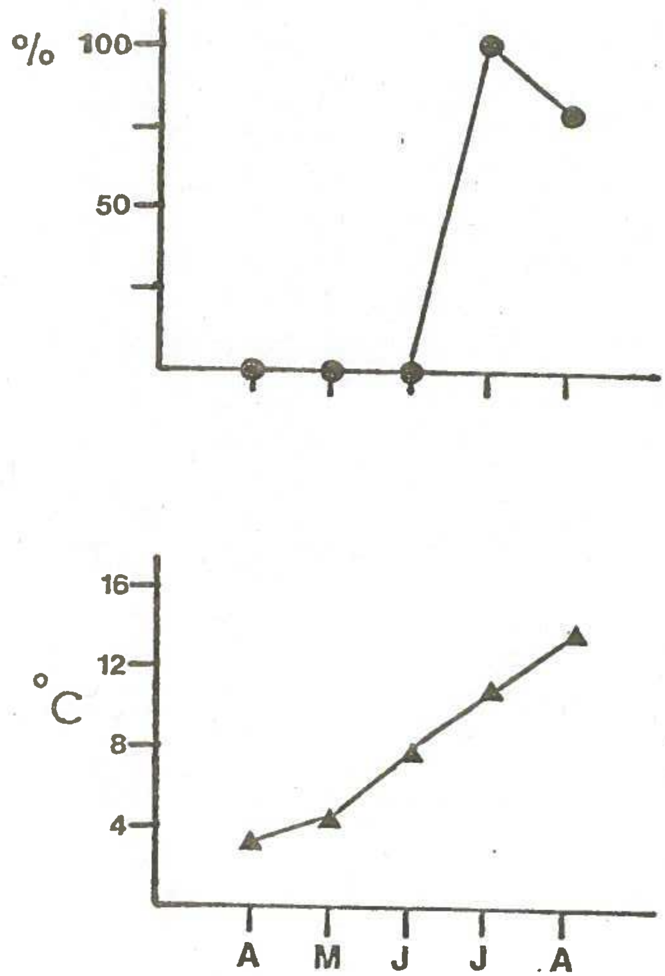

Figure 11. Percentage of collections with incubating or expelled tailed larvae of *Amaroucium glabrum*. Sea temperatures at Cape Blomidon.

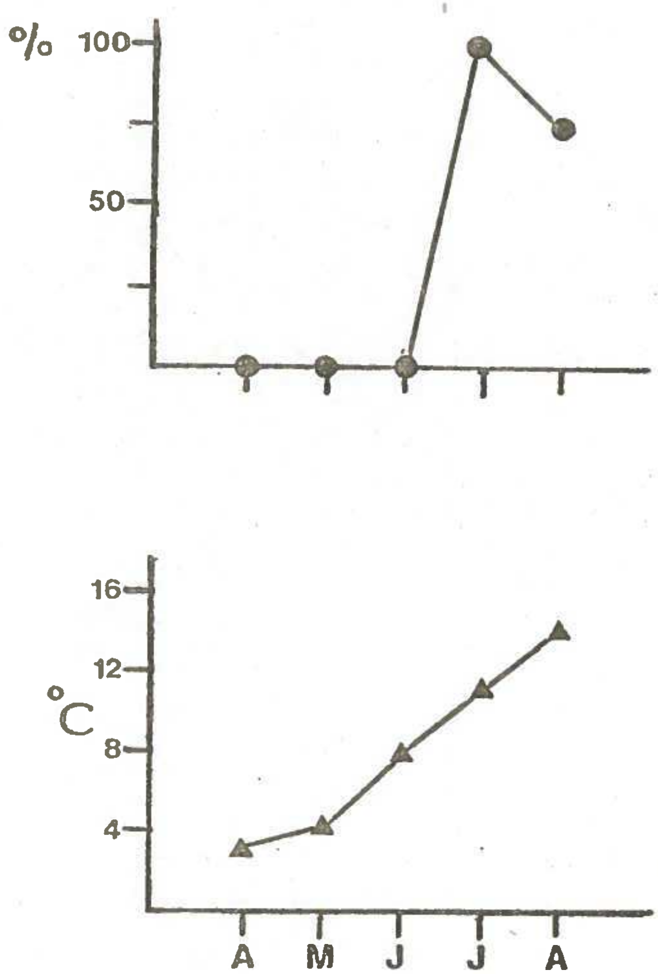

Figure 12. Percentage of collections with incubating or expelled tailed larvae of *Didemnum albidum*. Sea temperatures at Cape Blomidon.

IV. ACKNOWLEDGEMENTS

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Jim Fuller

Jack Trevors

Project Leaders.

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VI. APPENDIX

LIST OF PHOTOGRAPHS

24 Kingsport salt marsh, June 1977.

25 Kingsport runoff stream, low tide, June 1977.

26 Kingsport runoff stream, high tide, June 1977.

27 Kingsport salt marsh, insect study site K1, June 1977.

28 Kingsport salt marsh, insect study site K2, June 1977.

29 Kingsport salt marsh, insect study site K3 at low tide, June 1977.

30 Kingsport salt marsh, insect study site K4 at low tide, June 1977.

31 Kingsport salt marsh, insect study site K6 at low tide, June 1977.

32 Kingsport salt marsh, salt marsh pools, June 1977.

33 Wolfville salt marsh, low tide, June 1977.

34 Wolfville salt marsh, insect study site W1 at low tide, May 1977.

35 Wolfville salt marsh, insect study site W2 at low tide, May 1977.

36 Wolfville salt marsh, insect study site W4 at low tide, May 1977.

37 Wolfville salt marsh, drainage ditch sampling area, low tide, May 1977.

38 Pereau beach, low tide, July 1977.

39 Kingsport, low tide, July 1977.

40 Kingsport, high tide, July 1977.

41 Cornwallis River at Port Williams Bridge, low tide, July 1977.

42 Cornwallis River at Port Williams Bridge, high tide, July 1977.

43 Starrs Point, low tide, July 1977.

44 Starrs Point, high tide, July 1977.

45 Starrs Point, high tide, July 1977.

46 Starrs Point, low tide, July 1977.

47 Starrs Point, low tide, July 1977.

48 Starrs Point mud bar, low tide, July 1977.

49 Porters Point, high tide, July 1977.

50 Porters Point, low tide, July 1977.

51 Porters Point, low tide, July 1977.

52 Scots Bay Wharf, temperature and salinity station, low tide, July 1977.

53 Scots Bay Wharf, temperature and salinity station, high tide, July 1977.

54 Evangeline Beach, low tide, July 1977.

55 Evangeline Beach, high tide, July 1977.

56 Evangeline Beach West, low tide, July 1977.

57 Salinity station number 2, high tide, July 1977.

58 Salinity station number 3, high tide, July 1977.

59 Salinity station number 3, low tide, July 1977.

60 Salinity station number 4, high tide, July 1977.